

Pima County
**MULTI-SPECIES
CONSERVATION PLAN**
2018 Annual Report



March 1, 2019

Submitted to the U.S. Fish and Wildlife Services, Southwest Region in partial fulfillment of Incidental Take Permit: TE-84356A-0

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Cover species: Mexican long-tongued bat, Sonoran desert tortoise, lowland leopard frog



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1 Introduction

Pima County’s Section 10(a)(1)(B) Incidental Take permit (herein Section 10 permit or permit) for the Pima County Multi-species Conservation Plan (MSCP; Pima County 2016) was signed by the Pima County Administrator on July 13, 2016. This report is prepared for the U.S. Fish and Wildlife Service (USFWS) under Incidental Take permit #TE84356A and covers the time period January 1 through December 31, 2018.

Most of the activities discussed in this annual report occur on lands managed or regulated by Pima County and/or Pima County Regional Flood Control District (RFCD), the two permittees under the Section 10 permit. (Pima County and RFCD are herein referred to collectively as “Pima County” unless otherwise noted).

The permit area is located within Pima County, Arizona (Figure 1). Land ownership in Pima County is primarily tribal, federal and state trust land (Figure 2).

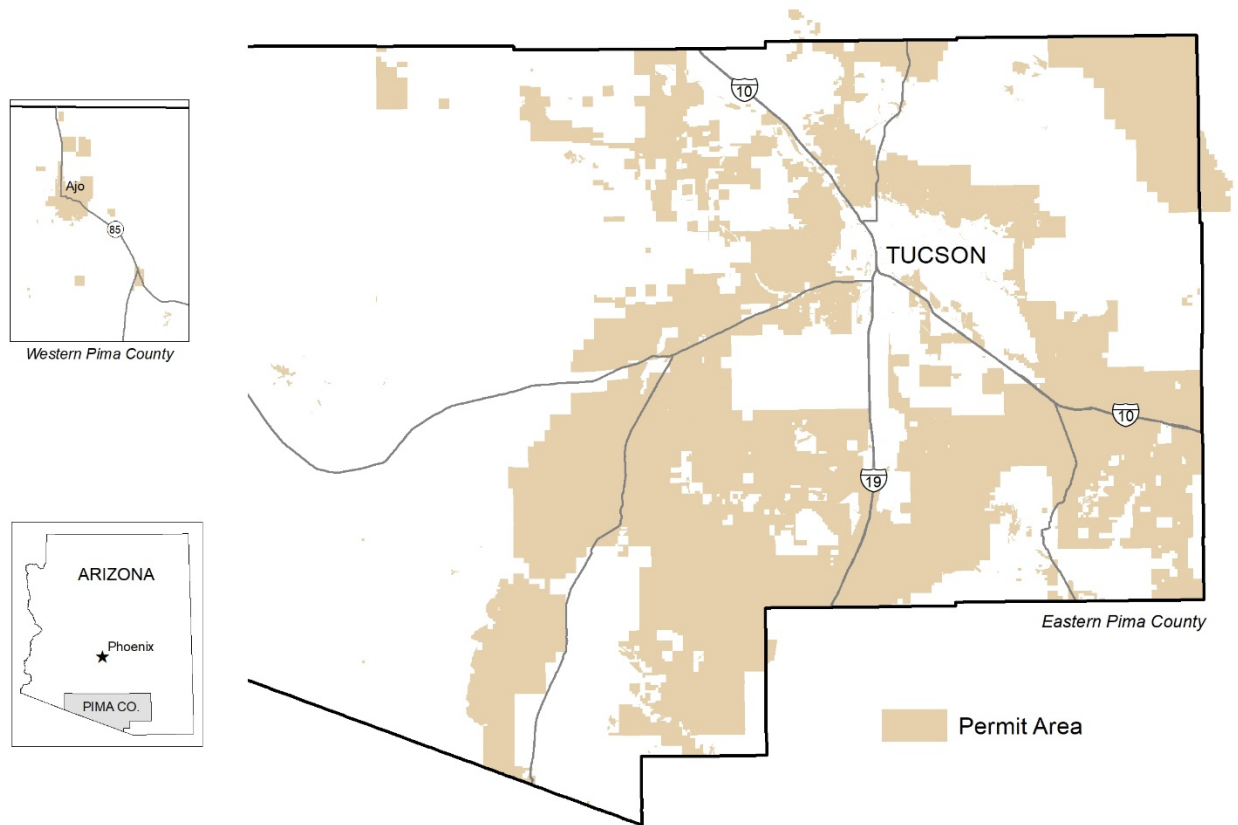


Figure 1. 2018 Permit Area of Pima County’s Multi-species Conservation Plan.

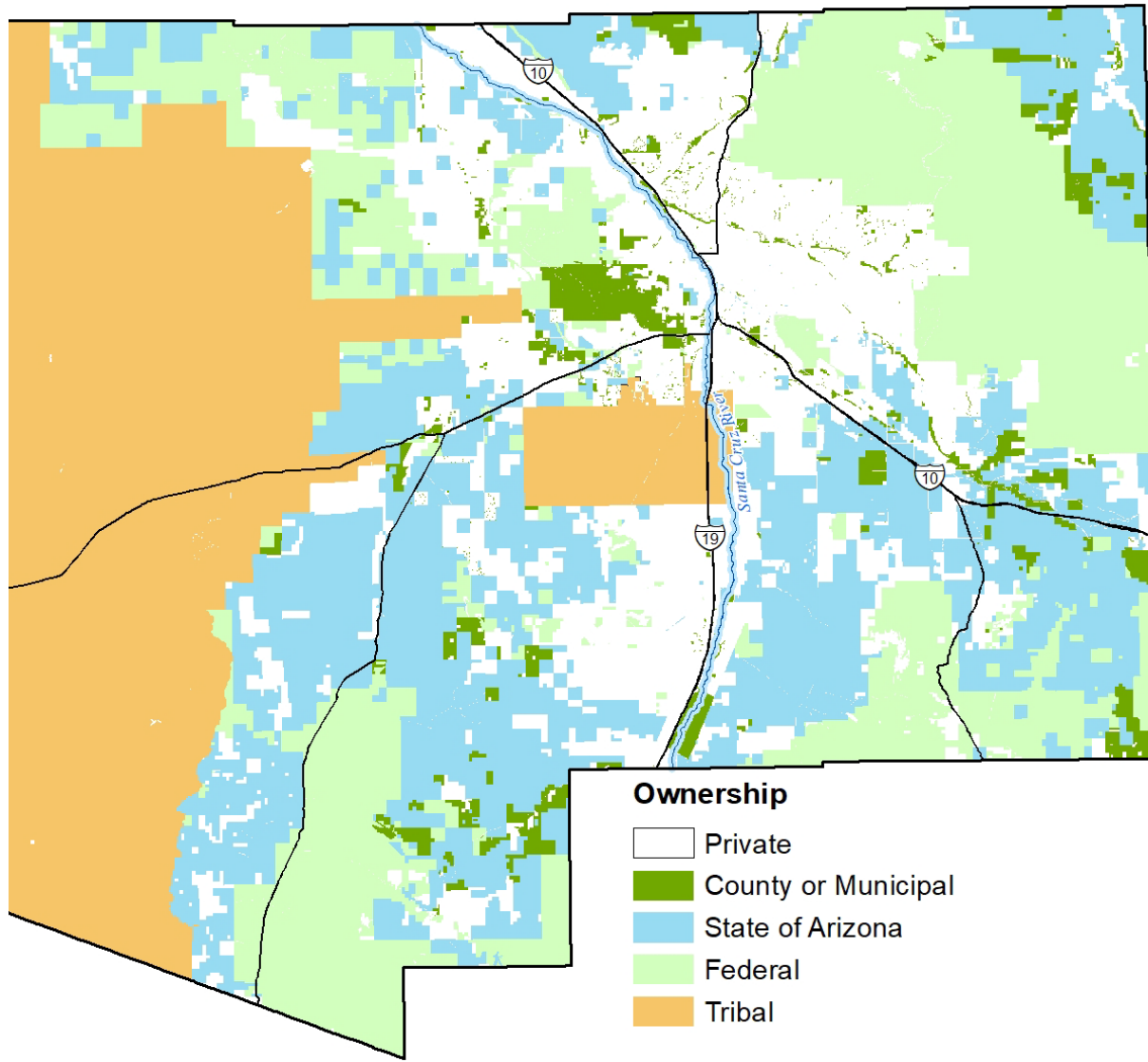


Figure 2. Land ownership in eastern Pima County, as of December 31, 2018. See Figure 3 for location of changes in land ownership during the reporting period.

Annual reporting is required under the terms of the permit. The primary purposes of this annual report, as described in Chapter 9 of the MSCP, are to:

1. Quantify impacts of Covered Activities and mitigation for these impacts;
2. Provide updates on the implementation of the MSCP; and
3. Inform the decision-making process if conditions of the permit or Implementing Agreement are not being met, or when adaptive management is needed.

The format of this report follows the template in the Appendix P of the MSCP. A glossary of terms and acronyms (Pages 60-62) is included to assist the reader and ensure consistency between this document and the MSCP.

2 Permit Changes

No amendments to the MSCP or permit language changes occurred during the reporting period.

3 Administrative Changes

3.1 Permit Area

The Permit Area represents the area within which Covered Activities could occur and has changed slightly during 2018 (Figure 3)—as compared to its description in the MSCP—for the following reasons:

- Annexation has the effect of slightly reducing the Permit Area in which coverage of private activities would become available. Annexations are shown in blue in Figure 3.
- Federal land acquisitions (red in Figure 3) reduce the permit area. Private land acquisitions of state trust land (green in Figure 3) reduce the permit area.

The permit area also includes locations where Covered Activities by the Permittees occur, principally on the potential mitigation lands in other counties and where the Permittees work in incorporated areas. In 2018, Pima County acquired land in Pinal County.

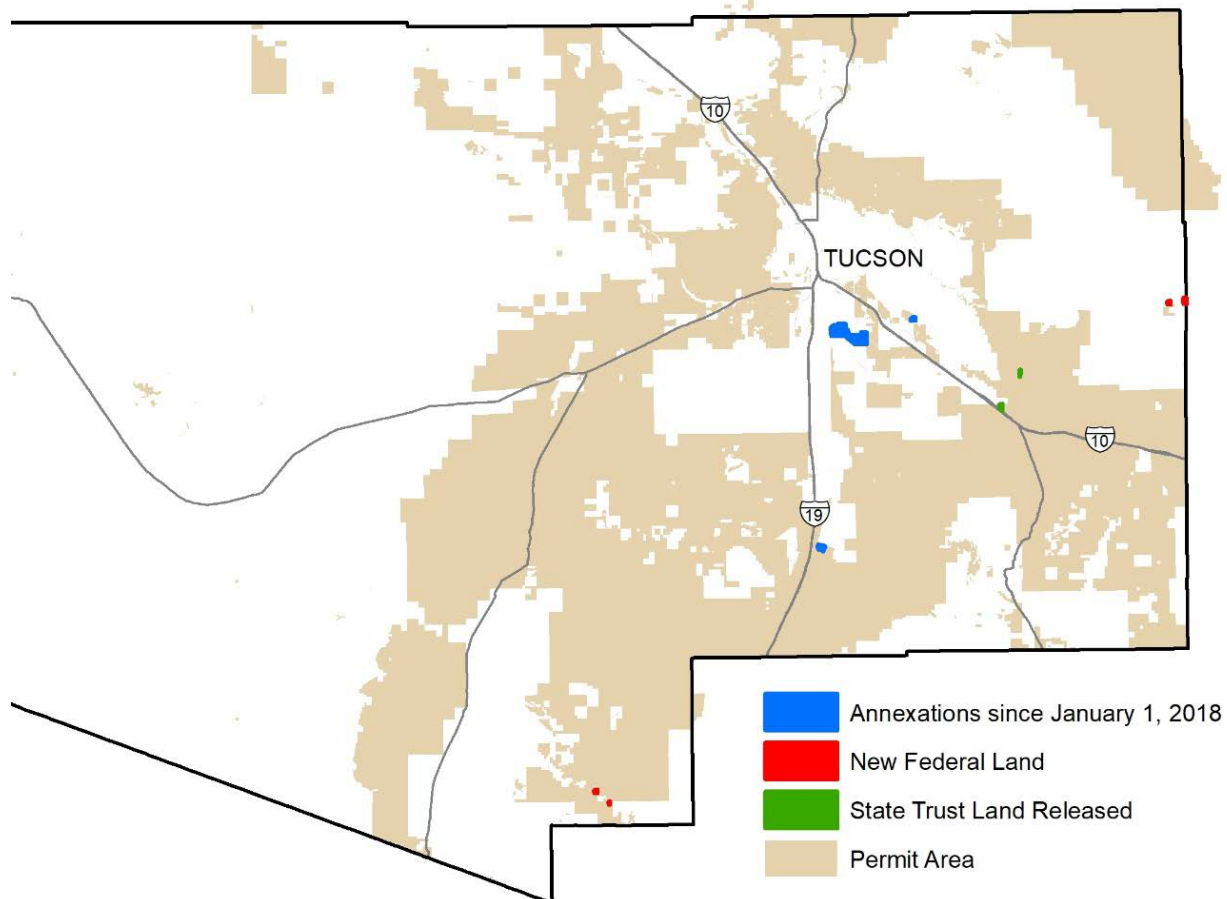


Figure 3. Permit Area changes for Pima County’s Multi-species Conservation Plan, January 1 through December 31, 2018. Annexations and a federal land acquisition slightly diminished the Permit Area extent; state land released to private development increased it near Vail.

3.2 Land Protection

Restrictive covenants were not added to potential mitigation lands during 2018. Potential mitigation lands are discussed further in Chapter 10.

3.3 Army Corps of Engineers Programmatic Consultation

Pursuant to the programmatic consultation with U. S. Army Corps of Engineers (Corps), Pima County worked with the USFWS and the Corps streamline Endangered Species Act compliance for the 18 nationwide and regional general Clean Water Act permits listed in the MSCP. The USFWS, Corps, and Pima County agreed to report annually on the status of Corps permits issued in relation to the Section 10 permit. The report is included in Appendix 1. The reporting process is still being worked out with the Corps, but in general, it lists the status of projects where the Corps issued a Section 404 permit contingent on the MSCP. In 2018, the Corps did not issue any 404 permits for projects that relied on this streamlined process (Kevin Grove, Michael Cabrera, personal communications to Julia Fonseca).

3.4 Miscellaneous Administration Items

- There were no changes to habitat models or Priority Conservation Areas.
- The Lesser Long-Nosed Bat was removed from the federal list of Endangered and Threatened Wildlife due to recovery actions. The bat will continue as a covered species under this plan.
- The Sonoyta mud turtle is proposed for critical habitat. This is not a covered species and there is no potential for take in the permit area.
- There were no information requests in 2017 by the USFWS to Pima County for the purpose of assessing whether the terms and conditions of the permit are being met.
- USFWS staff reviewed the draft Bingham Management Plan and provided comments, which have been addressed in the current version (Appendix 2).
- USFWS concluded Pima County does not need a 10(a)(1)(A) permit for use of topminnow as vector control, as they are already permitted under the MSCP.
- USFWS clarified that Pima County is no longer required (as specified in incidental take permit TE84356A-0) to obtain a special use permit under the Migratory Bird Treaty Act. A December 22, 2017 Solicitor's Opinion now holds that the take of a migratory bird, its nest or eggs due to incidental (and otherwise lawful) activities does not violate the MBTA.
- USFWS determined there are no additional regulatory requirements pertaining to covered species for the District's activities in Santa Cruz River habitat of topminnow. The USFWS requested to be advised if potential effects to covered species could be reduced through salvage and relocation, or the temporary holding of animals (see Appendix 3).
- USFWS advised that the permanent educational display of Gila topminnow at County facilities such as Agua Caliente Park is a covered activity under the MSCP (personal communication from Scott Richardson to Brian Powell, October 3, 2018).
- For approved adjustments to ecological monitoring, see Chapter 7
- USFWS advised that Pima County may move Pima Pineapple Cactus salvaged from one County-owned property to another County-owned property without additional federal permits or monitoring obligations (personal communication from Julie Crawford to Julia Fonseca, Feb. 22, 2018). The local office would appreciate any follow-up information on how transplants fare.

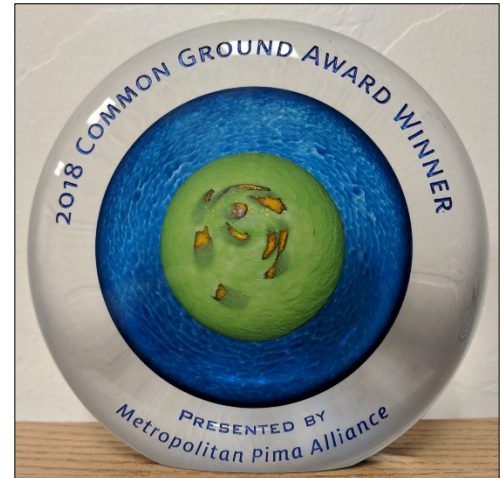
4 Incidental Take

This section describes incidental take caused by the covered activities identified in the MSCP. As noted in section 3.7.1 of the MSCP, incidental take is determined by acres of habitat loss and reported take of individuals.

4.1 Certificates of Coverage - Development on Private Land

The Certificate of Coverage Program (www.pima.gov/S10PrivateLand) affords the developer of a home, subdivision, commercial, or industrial project an opportunity to comply with the ESA for activities that are permitted by the County. Participation in the program is voluntary and in the sole discretion of the private developer. A total of 151 projects have been authorized to receive coverage since the program began in 2017. Authorization for incidental take remains in effect for six years from the date of issuance; coverage is granted when project grading is complete. To date, no certificates have expired and a total of 58 projects have received coverage.

In 2018, 44 projects received coverage subsequent to completion of grading (Table 1, Figure 4) resulting in a loss of approximately 156 acres of habitat.



The Certificate of Coverage Program won the 2018 Metropolitan Pima Alliance Common Ground “Programs and Policies” Award, which honors “programs that have made significant contributions toward bridging divides and finding solutions to complex challenges in creative ways.”

Table 1. Certificates that provided permit coverage for private development in 2018, Pima County.

Certificate of Coverage #	Actual Habitat Loss Acreage
P17CC00010	34.17
P17CC00011	3.34
P17CC00021	7.71
P17CC00023	1.65
P17CC00028	0.91
P17CC00029	5.01
P17CC00030	3.48
P17CC00031	1.09
P17CC00032	3.79
P17CC00033	4.05
P17CC00034	4.81
P17CC00035	2.17
P17CC00038	1.46
P17CC00039	1.01
P17CC00040	1.42
P17CC00042	1.05
P17CC00043	3.08
P17CC00044	1.49
P17CC00050	1.64
P17CC00051	2.44

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P17CC00052	0.72
P17CC00053	3.73
P17CC00054	4.90
P17CC00055	3.38
P17CC00057	1.35
P17CC00062	1.03
P17CC00065	1.30
P17CC00066	0.92
P17CC00068	3.49
P17CC00069	4.26
P17CC00070	1.61
P17CC00072	0.95
P18CC00001	1.56
P18CC00002	4.11
P18CC00007	3.47
P18CC00009	1.64
P18CC00010	3.79
P18CC00012	1.10
P18CC00013	4.20
P18CC00014	4.39
P18CC00016	9.63
P18CC00017	4.14
P18CC00019	1.01
P18CC00030	3.33
TOTAL	155.76

4.2 County Capital Improvement Projects

There were 47 County Capital Improvement Program (CIP) projects covered by the permit in 2018 (Appendix 4). Of these, four required mitigation and these are shown on Figure 4. Many of the covered projects listed in Appendix 4 did not cause ground disturbance, and others occurred in the built environment where no mitigation is required. A County CIP project is reported as a Covered Activity whenever it is determined to be “substantially” complete, which is after most of the earthwork is done, but prior to completion of all activities such as landscaping and payment of invoices. Covered Activities also include non-CIP projects and activities that occurred in various locations throughout the permit area but these are not required to be listed each year in the annual report.

Appendix B of the MSCP describes the methodology used to calculate take for Covered Activities. For the impacts caused by the County, this involves tracking the location and size of areas altered by CIP projects. The tracking process for CIP projects has been in place for several years and requires the submittal of Geographic Information System (GIS) “polygons” which describe the location and aerial extent of completed projects. This tracking process is discussed in greater detail in Section 5.2 of this report. Private sector impacts are tracked using a combination of Accela and ArcGIS. GIS acres, not survey data, are the basis for impact acreages.

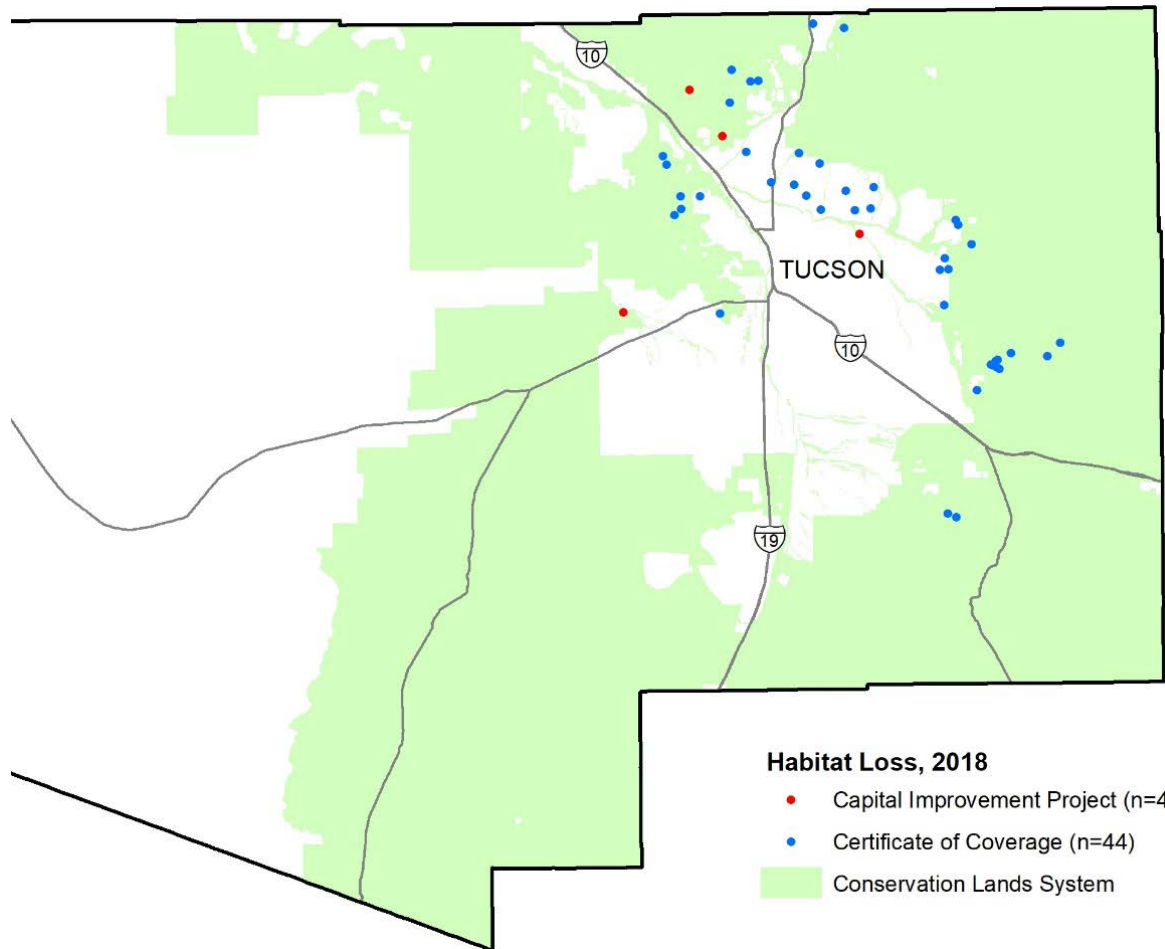


Figure 4. Location of habitat loss due to Covered Activities, January 1- December 31, 2018. Locations are enlarged for clarity. All ground-disturbing County Capital Improvement Program (CIP) projects outside the built environment so none required mitigation. Private projects may elect coverage through the Certificate of Coverage program, and each such project receives mitigation.

The built environment layer used for tracking impacts is not always accurate, and this resulted in the need to discuss how to do impacts tracking for several park projects with USFWS. Parks are often a mixed of developed and natural areas. In 2017, activities at Agua Caliente and Canoa Ranch parks affected developed area and USFWS agreed that they did not require mitigation. As part of the landscape pattern protocol, Pima County intends to present a comprehensive update of the built environment based on the 2016 Land Use-Land Cover mapping by Regional Flood Control District that would provide a more accurate and comprehensive basis for CIP impacts tracking in the future.

4.3 Covered Activities Impacts

Polygons for ground-disturbing CIP projects that were substantially completed on or before December 31, 2018 were used to calculate impacts. The project polygons were checked to ensure ground disturbance was correctly identified. The list of ground-disturbing projects was then screened to eliminate any on federal or tribal lands, as these impacts are not covered under the permit. The remaining projects were intersected with the Built Environment GIS

layer (known as [CIPBUILT](#)). Those portions outside the built environment, or federal or tribal lands, were then intersected with the Maeveen Marie Behan Conservation Lands System (CLS) to determine the habitat loss, as described in Appendix B of the MSCP. Each CLS category has a specific mitigation ratio that is used to calculate the MSCP mitigation obligation (as described in Section 4.3.1. of the MSCP).

In 2018, four ground-disturbing CIP projects (Figure 4; Appendix 4; totaling 75.0 impact acres) required the County to provide 343.9 acres of CLS mitigation. The largest project requiring mitigation this year was the Tangerine Road project. Private sector impacts required 630.6 acres of mitigation.

Table 2 summarizes the total acres of impact for both CIP and private development, along with the CLS category and mitigation ratios applicable to these impacts. There was 230.8 acres of loss in 2018; consequently, Pima County will provide 974.4 acres of mitigation to compensate for impacts occurring in 2018.

Table 2. Habitat loss and associated mitigation ratios for 2018, Pima County MSCP.

CLS category	Habitat Loss Acreage	Mitigation Ratio	Mitigation Obligation
Biological Core	73.0	5:1	364.9
Important Riparian Area	23.6	5:1	117.7
Multiple Use Management Area	47.2	3:1	141.5
Special species management area (outside other categories)	58.7	5:1	293.6
Outside the CLS	28.4	2:1	56.7
Total	230.8		974.4

5 Conservation Measures

5.1 Avoidance and Minimization

5.1.1 Changes to Ordinances and Standards

In 2018, there were no changes to avoidance and minimization measures as described in Section 4.2 of the MSCP.

5.1.2 Certificate of Coverage-Native Plant Preservation Streamlining

In 2018 Pima County developed a procedure that allows private developments to rely on a Certificate of Coverage to streamline compliance with certain provisions in Pima County Code 18.72 – Native Plant Preservation. Specifically, this procedure allows the Pima pineapple cactus (PPC), needle-spined pineapple cactus (NSPC), and Huachuca water-umbel (HWU) mitigation the County provides for a private development project receiving a Certificate of Coverage to be used as off-site mitigation for purposes of complying with the Native Plant Preservation Ordinance (NPPO). Under this new procedure, private developments will be allowed to rely on a Certificate of Coverage to serve as off-site mitigation for purposes of fulfilling replacement and supplemental PPC, NSPC, or HWU, consistent with the NPPO requirements (Section 18.72.090.B).

One private development utilized this new procedure in 2018, the Sycamore Vista (formerly “New Tucson”) development. The developer obtained two authorized Certificate of Coverages (P18CC00042 and P18CC00043) for two phases of the development and relied on those to meet mitigation obligations under the County NPPO requiring replacement and supplemental PPC. The developer was further allowed to rely on those Certificates to meet mitigation obligations for PPC as required under the development’s existing Clean Water Act Sec. 404 permit (Permit No. SPL-2002-00992-KAT), per an agreement with USFWS and the Army Corps of Engineers.

5.2 CIP Screening and Reporting Process

No substantive changes in the CIP screening and reporting process occurred in 2018, however additional trainings were held to ensure project managers comply with procedures for close-out polygons. The screening process notifies CIP project managers of the intersections between proposed project locations, site-specific natural resources, and protected areas in order to promote avoidance and minimization during planning. The Pima pineapple cactus Priority Conservation Area, burrowing owl Priority Conservation Area, potential bat habitat under bridges, and the need for floodplain compliance are specifically included. A new enhancement allows project managers to view past CIP projects relative to proposed CIP projects.

Advice on avoidance and minimization for individual projects is provided by environmental compliance personnel in various County departments, and by Office of Sustainability and Conservation as requested.

5.3 Gila Topminnow for Vector Control

In 2017, County staff began using Gila topminnow for vector control, as outlined in section 3.4.1.2.1 of the MSCP. In 2018, only one “green pools” or cisterns was stocked with Gila

topminnow by the Health Department (Figure 5, Appendix 5), as homeowners have been treating or otherwise draining their pools. Several others were evaluated, but found inappropriate due to limited volume or oily water. Health Department received several calls from pool owners who would like to obtain the topminnow, but upon contact, the homeowners wanted the fish to place in their fish tank or ponds that already had gold fish or Gambusia fish in them.

Placement of topminnow is subject to numerous requirements intended to ensure the topminnow do not inadvertently escape from the swimming pools and other contained, mosquito-ridden water bodies where Health Department staff may place them. For example, topminnow are not placed in washes or locations that may overflow into washes. There is no obligation for the owner who accepts fish from the Health Department to feed or maintain the fish, and take is reported when the animals are stocked at the site.

Fish at Work!



This neglected pool has been treated with fish to control mosquito breeding.

Do not put chemicals in the water!

If you need to correct the pool or have questions, call 520-724-7908 or visit pima.gov/health



3950 S. Country Club Road, Suite 100 • Tucson, AZ 85714

Figure 5. Health Department placard used on fetid pools that are treated with topminnows.

Pima County is the first Health Department in the state to use the Gila topminnow, and another county has expressed interest in utilizing the species as a tool for reducing the threat of mosquito-borne diseases. During 2018, David Ludwig presented on the topic at the 2018 Vector Conference in Maricopa County. Health Department has also promoted the topminnow at Tucson Meet Yourself and other community events.

5.4 Riparian Avoidance and Minimization Measures

The RFCD reported a substantial increase in the number of riparian habitat reviews over last year. Last year 1745 reviews occurred versus 2292 for 2018. Of these, 95.8% of the applicants avoided impacting regulated riparian habitat. In other words, there were 2,196 instances of avoidance of regulated riparian habitat impacts. There were 81 minimization actions, where impacts were limited to less than 1/3 of an acre disturbance. Fifteen (15) instances required riparian mitigation in addition to minimization.

5.5 Other Avoidance and Minimization Measures

- The Priority Conservation Area for the Pima pineapple cactus is shown on the Sonoran Desert Conservation Plan Mapguide as required by the MSCP.
- No weed ordinance letters or violations were issued on MSCP or potential MSCP mitigation lands.
- Two hundred and forty-nine (249) weed and trash ordinance letters were sent to private property owners this year.
- Five buffelgrass advisement letters were issued. None of the complaints were regarding any County or RFCD-managed potential mitigation lands.

5.6 Mitigation and Allocated Lands

To compensate for the take of Covered Species, Pima County allocates credits as described in Appendix B of the MSCP. Land that has become allocated is known herein as Mitigation Land. Bingham Cienega Natural Preserve, located along the San Pedro River was the County's first Mitigation Land property. This year, credits from additional lands in the Bingham Planning Area have been allocated, along with credits from allocated lands in the Cienega Natural Preserve (Figures 6 and 7).

The number of acres of credits available is determined by the Mitigation Land's acreage and the level of legal protection that the property has. When Mitigation Land is owned in fee title (as opposed to owning partial rights or a grazing lease), the property acreage is eligible for 100% credit.

The inventory of potential mitigation lands and where allocations have occurred are represented in Figure 6 and in [MSCPPORT](#), a GIS layer that summarizes the diverse portfolio of lands which may be used for credit under the MSCP. (This layer may now be viewed in greater detail by the public on the [SDCP Mapguide](#) site.) Appendix 6 provides a parcel list of lands allocated so far.

The CLS designations are an index to an area's biological value and are used to ensure the quality of Mitigation Land is of equal or higher value than the land where take occurred (see

Appendix B and page 49 of the MSCP for more information). The Bingham allocations are primarily Important Riparian Area and is also a CLS-designated Special Species Management Area. The deeded lands allocated in the Cienega Creek Natural Preserve are primarily CLS-designated Important Riparian Areas and Biological Core. The new allocations provides habitat for many different covered species than were available in the Bingham Planning Area alone.

The credits for deeded lands allocated at Bingham and in Cienega Creek Natural Preserves exceed the mitigation obligation for take for 2016-2018 (Table 3), therefore the mitigation obligation has been satisfied. The 2016-2018 CLS obligations are summarized in Table 4. CLS obligations for Multiple Use and Outside of CLS can be met by any higher categories, such as Biological Core, Important Riparian Area, or Special Species Management Areas. Bingham is primarily Important Riparian Area, but the Cienega Creek offers a wider array of CLS categories, including Special Species Management Area.

Allocations trigger a timeline for management plans. The Bingham Management Plan is completed and is discussed further in Section 6 of this report. A new management plan will be prepared for the Cienega Creek Natural Preserve and its environs by March 1, 2021.

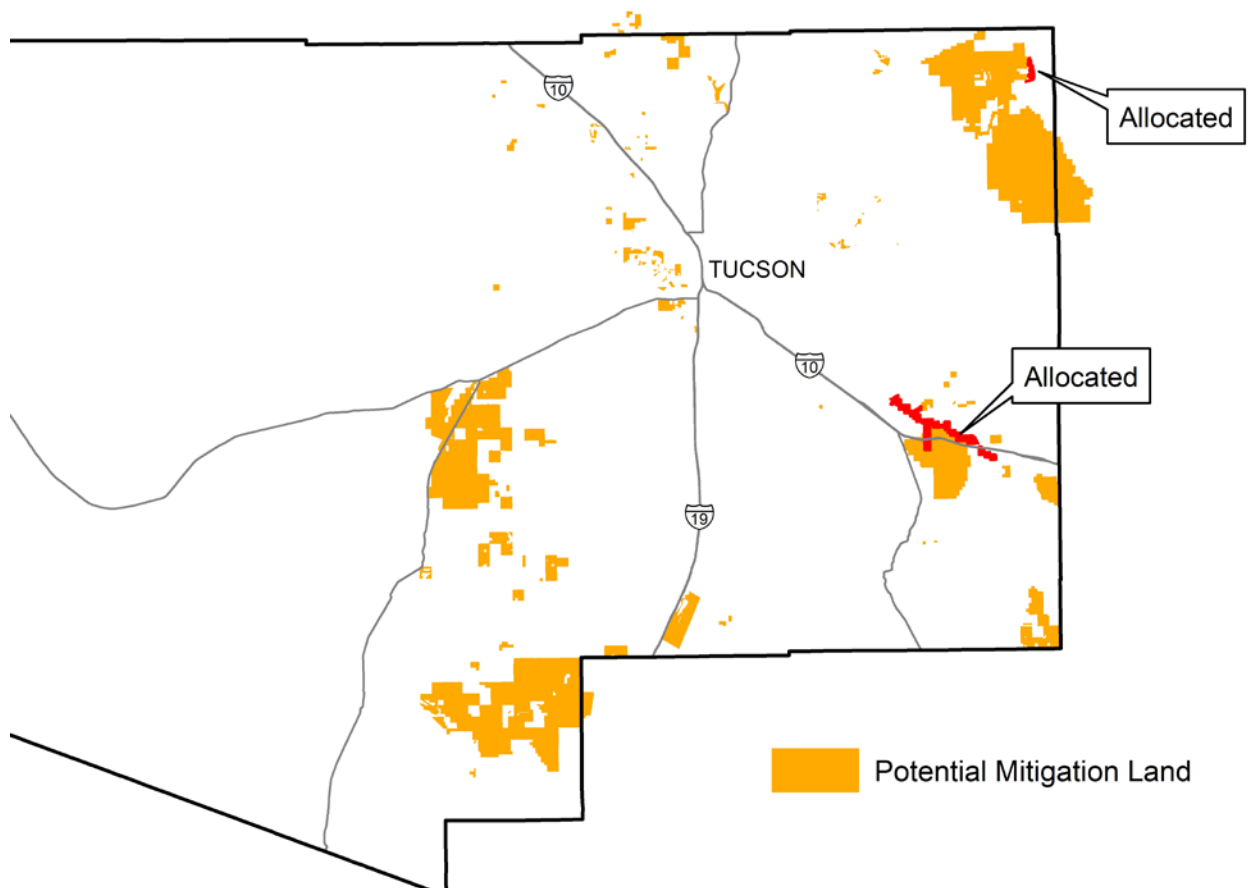


Figure 6. Location of all mitigation lands allocated under the MSCP to date. These areas consist of the Bingham Planning Area and the allocation of the Cienega Creek Natural Preserve, shown in relation to other potential mitigation lands managed by Pima County.

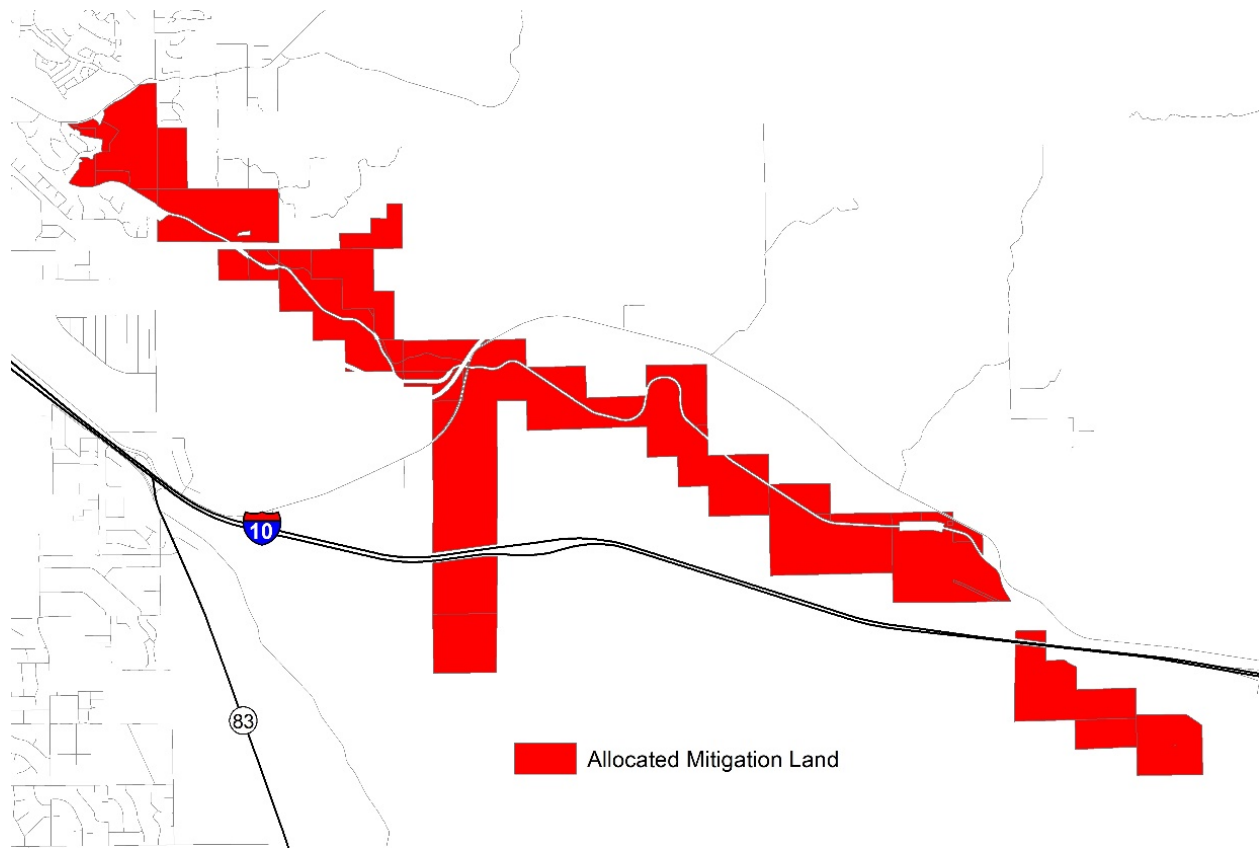


Figure 7. Detail of the allocation of Mitigation Land in the Cienega Creek Natural Preserve to offset take that occurred during the 2018 Section 10 permit reporting period. The allocation outlined in blue does not include a small parcel of land under the Colossal Cave bridge (not visible at this scale).

Table 3. Mitigation credits obligated and allocated for the Pima County MSCP by year

Year Obligated	Mitigation Obligation	Mitigation Allocated
2016	52.6	267.0
2017	171.7	0
2018	977.3	4140.5
Total (to date)	1201.6	4140.5

Table 4. Cumulative CLS mitigation credits obligated and allocated for the Pima County MSCP.

Category	CLS Obligation	Cumulative Allocation
Biological Core	404.7	2059.2
IRA	215.1	2122.3
Multiple Use	159.0	223.4
Outside	129.1	2.7
SSMA on MU or Outside*	293.6	0
TOTAL (to date)	1201.6	4407.5

*These obligations are met with any combination of Biological Core, IRA, or SSMA.

As part of the 10-year review, Pima County will review the habitat equivalency for individual species (as discussed in MSCP Section 4.3.3.) such that a minimum 1:1 ratio of habitat loss: acres of mitigation will be maintained for each Covered Species.

No replacement of lost mitigation credit was needed in 2018.

5.6.1 Water Rights in Relation to Mitigation Lands

The restrictive covenants for the deeded Mitigation Lands limit the kinds of uses to which water can be put by the County, and prohibit increased levels of surface water or groundwater use by County without permission from USFWS and others.

A portion of the new allocations of land in the Cienega Creek Natural Preserve are located in the Tucson Active Management Area, an area where groundwater uses are subject to regulation. Pima County holds some groundwater rights on the allocated properties.

Pima County has a policy of managing water rights on County land and to do this, Pima County has a process to assure that water right claims are transferred to the County or RFCDD upon acquisition of a property. Water rights quantify amounts and uses to which surface waters may be placed, and identify priorities in times of shortage. There are a number of historic water claims and other uses which Pima County inherited with land acquisitions.

Pima County and the District are participating in the adjudication of water rights in the Gila River watersheds, along with many other parties in the state. The San Pedro watershed is being adjudicated first. The Sands and the Clyne ranches, County-owned MSCP lands, are located at the very top of the Babocomari watershed, a major tributary to the San Pedro River. In 2017 and 2018, the Special Master accepted the County's stock pond and stockwatering claims for both ranches into the court's catalog of proposed water rights for the watershed.

The affected claims have now migrated from their former status as "claims", to their present status as water rights proposed by the Special Master for confirmation in the Gila Adjudication. While this is a favorable development, it needs to be mentioned that there are tens of thousands of other such claims that the court needs to address before anything approaching a final decision can be expected.

For the claims the County and RFCDD own in the San Pedro River watershed and the Santa Cruz River watershed, efforts are ongoing to correct the location, the claimed uses, and the consumption data at sites where historic claims affect MSCP lands in the Edgar, Buehman, and Peck watersheds, and along the San Pedro mainstem. Pima County will continue to protect our water rights at Bingham Cienega and other potential mitigation lands in the San Pedro watershed through participation in the San Pedro Adjudication, and through appropriate filings in the Gila Adjudication with ADWR and the Maricopa County Superior Court. The County Attorney's Office monitors new requests for surface water appropriations for threats to the County's own water rights, and continues to research the availability of additional pre-Statehood water rights claims to bolster the County's legal standing defense in the Adjudication.

6 Land Management

Land management actions on allocated lands must be reported annually. Therefore, this section summarizes management activities at Bingham Cienega Natural Preserve, our first allocated Mitigation Lands (see Section 5 of this report). Because of the importance of land management—and of the many actions Pima County is undertaking to promote sound stewardship of our extensive portfolio of mitigation lands—this section will also highlight key management actions and initiatives that impact this broader suite of conservation lands.

6.1 Park Designations

There were no new park designations on existing or potential mitigation lands in 2018.

6.2 Inspections for Restrictive Covenants

During 2018, ALWT reviewed biennial inspection reports submitted in 2017. The reviews were completed satisfactorily. The biennial inspection reports filed in 2017 identified an encroachment on one of the potential mitigation lands owned by the RFCD in Avra Valley. In 2018, the District addressed this encroachment. ALWT's reviews of biennial inspection reports provide an additional safeguard to USFWS's enforcement power under the restrictive covenants.

6.3 Land Management Activities and Planning: Allocated Lands

Pima County is required to report on management activities that took place on all allocated mitigation lands. As noted in Section 5, Bingham Cienega Natural Preserve is the first property to be allocated, and therefore, management actions and planning actions there will be the primary focus for this report. However, many other management practices have taken place on County-controlled lands that have an impact on Covered Species. Those actions will also be briefly reviewed.

6.3.1 Bingham Cienega Natural Preserve (Preserve)

The Preserve was established by RFCD in 1989 and is located on the west side of the San Pedro River, just north of Redington, Arizona and the confluences of Buehman, Edgar, and Redfield canyons. The Preserve historically provided habitat for threatened and endangered species such as the Huachuca water umbel and the Southwestern willow flycatcher.

The Preserve was originally purchased because of the Arizona ash-dominated Cienega and associated spring flows. Early management efforts focused on restoring abandoned farmlands with sacaton grass, mesquite and other native species. Site conditions changed significantly over the years as a result of drought and groundwater pumping outside of the Preserve, leading to a decline in groundwater levels at the Preserve that was documented in 2016 for the permit baseline.

6.3.1.1 Bingham Management Plan

Allocation of the Preserve in March 2017 triggered a two-year window to develop a management plan to be completed on or before March 1, 2019. The planning area (Figure 8), which includes portions of the M Diamond Ranch west of the San Pedro River Road, is larger than the area allocated in 2016 for mitigation in order to accommodate future allocations.

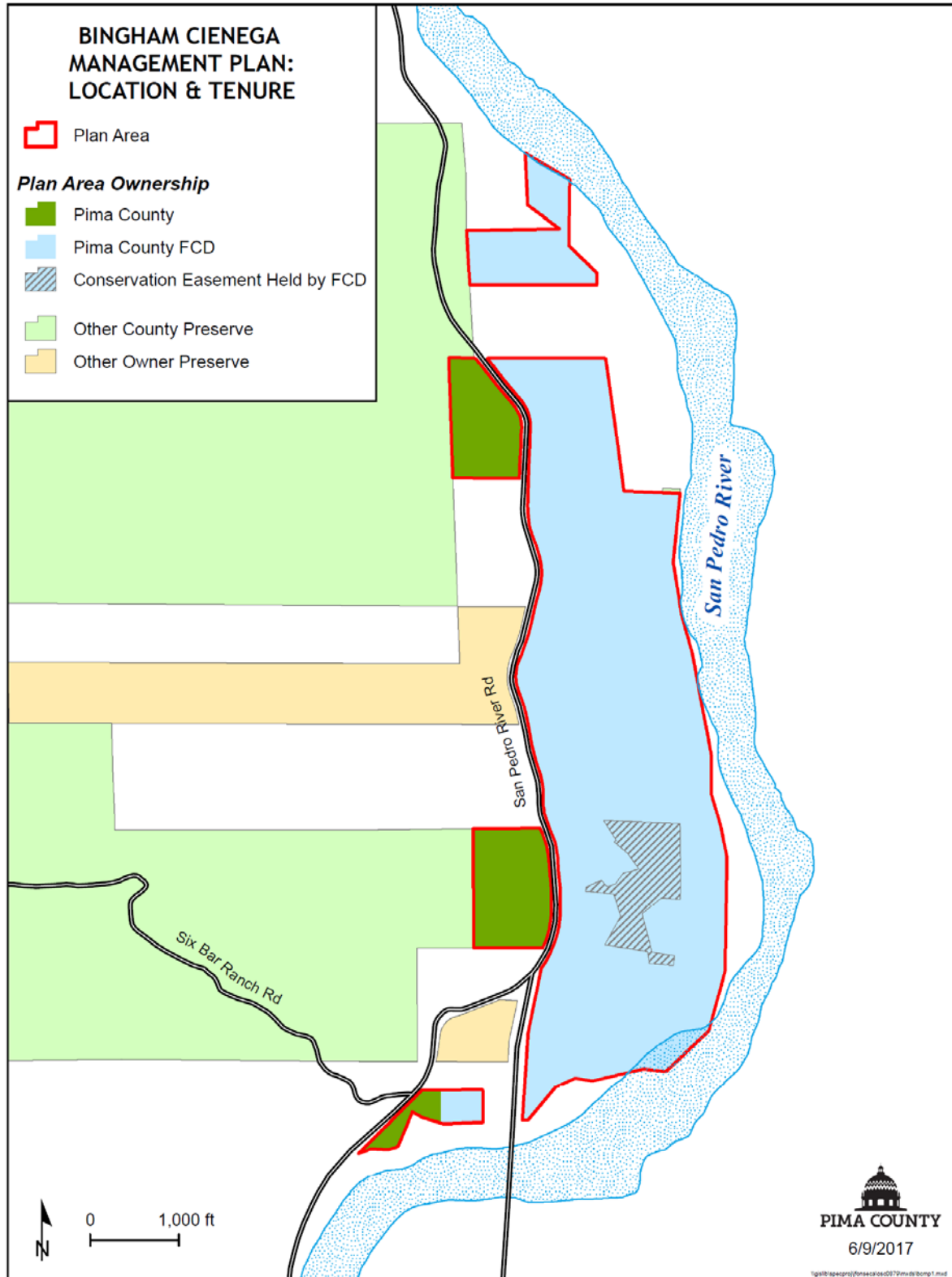


Figure 8. Map of the 405-acre Bingham management planning area. The 19-acre life estate (shown in hatched) is included in the management plan area, as well as the entire 267 acres of the Bingham Cienea Natural Preserve.

In 2018, USFWS, RFCD, and Pima County reviewed various drafts of the Management Plan. The draft plan was revised to address USFWS comments and is included as a final document in Appendix 2.

One of the principal planning needs was to prepare for the end of the life estate. The life estate land, includes a residence, an orchard, a pond, and ancillary agricultural lands and structures. Although it is not allocated as mitigation land, its use can affect the mitigation lands that surround it. The life estate inholding is subject to a conservation easement held by The Nature Conservancy (cross-hatched on Figure 8). The end of the life estate will trigger a need for cooperative action between Pima County and the RFCD to provide maintenance of the homestead. The management plan provides two principal alternative futures for the homestead, although hybrids are also possible: either an M Diamond Ranch personnel will occupy the home, or a non-ranch caretaker. Either way, we recommend that the resident be obligated to provide stewardship services for the 19-acre inholding, if not a larger area.

The plan provides potential opportunities for the rancher to use various facilities, including the pond, within the 19-acre inholding. One important limitation to future agricultural and ranch use in the inholding is the water budget. Under the terms of the restrictive covenant, the water budget may not be increased above the baseline set in 2016.

The water table in the area has been declining for many years and seems to be related to a lack of natural recharge and pumping outside the planning area. The declining water table represents a major planning uncertainty. While goals and objectives have been drafted around the current conditions, we ultimately have no control over climate conditions and offsite pumping. Our draft strategies emphasize improving the health of watersheds around the planning area, in particular M Diamond and Six Bar ranches, and understanding the effects of the pumping regime on areas upstream and adjacent to the Preserve along the San Pedro River.

The Preserve was once home to the Huachuca water umbel and lowland leopard frog, two covered species in the Section 10 permit. The Arizona Game and Fish Department also introduced the long-fin dace to the natural wetlands on the property. The lowered water table eliminated natural habitats for these species a decade ago. The pond in the life estate is maintained by groundwater pumping for sport fishing and irrigation, and is not allocated as mitigation. The non-native fish inhabiting the pond minimize native aquatic species potential, and while lowland leopard frogs have historically been observed in the pond, these individuals are likely prevented from successfully reproducing/colonizing this water body due to predation by the nonnative fish. After the life estate is completed, the pond could be managed for native species in concert with meeting ranch goals, or alternatively, we might provide covered species habitat at or near the former springhead. Either alternative would require continued groundwater pumping given the groundwater trends.

The last two decades of drought represent a period of elevated fire risks in the Preserve Planning Area. Arson and utility lines previously caused fires at the site in 2006. Past actions to reduce fire risk included installation of water-supply standpipe, clearing of the utility line, widening and extending existing fire lanes, and removing deadfall at the former springhead to

protect the nearby residence and improve access for fire suppression. Although no fires have occurred recently, the risks remain high. Restrictions on recreational access to the property, education of the new caretaker, and maintaining firebreaks are the principal strategies for reducing risk, along with the potential for targeted grazing of lands owned by RFCD to reduce fire fuels. We propose incorporating fire management strategies into a larger, multi-partner plan in the future.

Past activities and associated data for the Preserve is extensive, and includes restoration activities, hydrologic models and data, and a previous set of management plans, workplans, and fire management plans. However, many of these documents are outdated relative to current conditions. Also, relatively little was known about the other newly acquired properties within the planning area. Thus the focus of the planning team's work in 2018 has been to continue and initiate new studies of the plan area.

Work started in 2017 to document vegetation community extent and condition, and an update to the flora checklist is expected to be completed in 2019. Cultural Resource surveys were completed in 2018.

Oral interviews from the Kelly family are also informing the management planning. The Kelly's ran the M Diamond Ranch from their Bingham Cienega homestead prior to the sale of the ranch to Pima County in 2012, and currently maintain the 19-acre life estate parcel. In addition, and as part of a larger cultural resources outreach effort, the County is consulting with Native American tribes about the cultural significance of the property.

Staff has identified a number of conservation targets for the plan, and is discussing management objectives for each:

- Shallow groundwater and discharge,
- Tributary streamflow and recharge,
- Mesquite bosque and other distinct plant communities,
- Wildlife connectivity,
- Native aquatic species
- Cultural resources.

6.3.1.2 Management Actions at Bingham

The following are actions that took place at the Preserve through July 2018 (the most current reporting period).

Groundwater level monitoring. Depth to groundwater is measured at two wells on the property and one well just to the west. At all three wells, depth to water decreased an average of 2.5% during the reporting period, thereby showing slightly improved groundwater conditions.

Precipitation. Precipitation was recorded daily at the Preserve. There were 18.0 inches of rainfall recorded during the reporting period, similar to the average from 2007-2017 (17.1 inches; also a drought period), below the average from 1999-2017 (22.8 inches).

Fire management. Prior to permit issuance, changing conditions necessitated that management focus shift from restoration of the farm fields to fire management. Creating, expanding, and maintaining fire breaks (Figure 9) and promoting fire suppression actions—in part to protect the health and safety of the residents in the inholding within the Preserve —began in 2005 and continued as documented in last year’s MSCP annual report. The RFCD and Pima County Natural Resources, Parks and Recreation (NRPR) staff maintain firebreaks at the Preserve. Annual to semi-annual vegetation maintenance for this work includes vegetation clearing along specified routes to approximately 16 feet wide, such that a Type-6 Tinder Fire Response Vehicle may have ready access. Arizona Public Service (utility) previously cleared a 30-foot wide swath within their existing utility easement, and therefore RFCD incorporated this clearing into the maintained firebreaks.

Water Station. In 2018, operational signage was installed at the all-weather water station that was constructed in 2017 in the southern portion of fire unit 6 (Figure 10). The RFCD and NRPR believes annual testing of the water station will be necessary in 2019, since testing wasn’t completed in 2018. No pumped water was discharged for fire response in 2018. The current restrictive covenant language would require any future discharges for this purpose to be reported as a potential violation unless the “[RFCD] Board of Directors determines, based on clear and convincing evidence presented to said Board, is necessary to protect the public health, safety or welfare.” (Section 5.4 MSCP Restrictive Covenants). An update to the 2006 Fire Management Plan is contemplated due to changing condition of the vegetation and fuel-related hazards. Approval of the fire management plan by the RFCD Board of Directors and Supervisors will provide a basis for an exemption.

Fence maintenance. Perimeter fence repairs continued to be a focus in 2018, primarily as a result of falling trees that died due to past wildfires and continuing drought. In 2018, the Arizona Conservation Corp returned to the Preserve for the fourth consecutive year to work on fences and to assist with fire risk suppression efforts.

Remote Cameras. Two remote wildlife cameras were installed by RFCD and NRPR in 2018 for documenting feral pig egress through the site. Feral pigs have been known to utilize the Preserve off and on. Neighboring residential property owner’s work together to eliminate the feral pigs that move up and down the San Pedro corridor. In the early 2000’s there was concerted, yet unsuccessful, efforts to trap feral pigs in the Preserve. There continues to be feral pig sign including tracks, scat, and evidence of rooting in the historic Cienega Spring outflow at its confluence with the San Pedro. Pigs are not known to currently be wallowing in any areas of the Preserve, as they have done in the past. Two photos of pigs were recorded in 2018. RFCD and NRPR staff are discussing options and feasibility to maintain additional remote wildlife cameras.

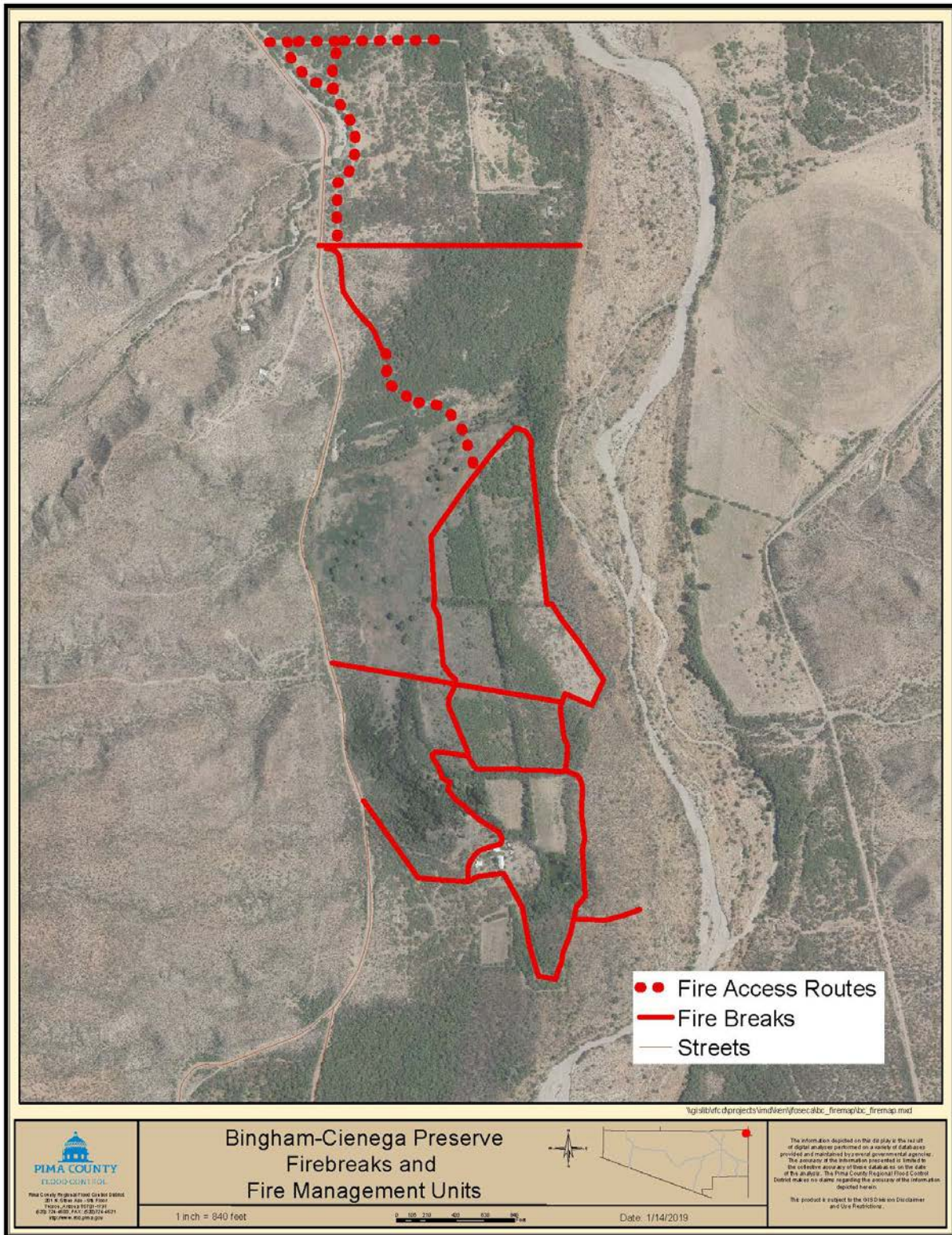


Figure 9. Existing firebreaks and fire lanes in Bingham Cienega Natural Preserve.



Figure 10. All-weather water station installed in 2017 and operational signage installed in 2018 at the Bingham Cienega Natural Preserve.

6.4 Land Management Activities and Planning: Unallocated Mitigation Lands

Staff from three Pima County departments also participate in a wide range of management activities on unallocated lands that help to preserve the value of these lands to Covered Species and their habitats. Key highlights of these management actions are included here, but this is not an exhaustive list.

6.4.1 Land-use Planning

6.4.1.1 Lower Altar Valley Area (LAVA) Resource Management Plan

Pima County is undertaking a landscape-level resource management planning process for the conservation properties in the Northern Altar Valley Reserve (at the northern, or lower, end of the Altar Valley). These include the County's Diamond Bell Ranch, King 98 Ranch, Buckelew, Verdugo, and Madera Highlands properties totaling approximately 37,270 acres (2,185 ac Pima County fee land, 35,085 ac AZ state trust land). Most of these properties are actively managed as working ranch lands, however they host a number of MSCP covered species including most notably dense populations of both Pima pineapple cactus and cactus ferruginous pygmy-owl. Additionally, the Northern Altar Valley Area habitat restoration project (highlighted below) is located within this planning area. The planning effort is being led by NRPR staff, with OSC and RFCD staff assisting as appropriate. The Altar Valley Conservation Alliance is a major partner in this effort, and other stakeholders will be brought into the process once initial goals and objectives are established. This resource management planning process has several goals:

1. Describe the known biological, cultural, and physical resources present within the planning area.

2. Highlight focal areas within the planning area important for different county programs, such as habitat conservation, range management, outdoor recreation, and cultural resource preservation.

3. Designate broad conservation goals and objectives which will inform individual resource management plans (i.e. ranch management plans) and county operations within the planning area.

6.4.2 Invasive Species Control

Pima County has a long history of making significant commitments to controlling invasive species, as evidenced by our being a founding member of the Southern Arizona Buffelgrass Coordination Center. Currently, staff in multiple departments participate in the newly formed Sonoran Desert Cooperative Weed Management Area focus group which provides a mechanism to increase collaboration and funding, exchange information, prioritize management goals, and highlight newly emerging invasive plant species in the region. Focal species for eradication efforts have included giant reed grass (*Arundo donax*), fountaingrass (*Pennisetum setaceum*), saltcedar (*Tamarisk* sp.), and especially buffelgrass (*Pennisetum ciliare*).



Figure 11. The Arizona Conservation Crew removes buffelgrass from the District's Rancho Fundoshi open space property (photo date 3/16/2018).

In 2018, Pima County staff, contractors, and volunteers mechanically removed or chemically treated approximately 1,300 acres of buffelgrass on County preserve lands (Figure 11). Pima County also treated and/or removed buffelgrass from approximately 15 miles of road right-of-ways.

6.4.3 Habitat Restoration Activities

Both the NRPR and RFCD departments have staff focused on habitat restoration activities, and this section highlights several projects that were initiated or completed in 2018.

6.4.3.1 Illegal Dumpsite Cleanup

During 2018, NRPR staff focused efforts on cleaning up rampant illegal dumping across roughly 4,700 acres of State Trust land on the northern part of Pima County's Diamond Bell Ranch. Approximately 90 tons of garbage were removed from these lands, including construction debris, household trash, target shooting debris, landscaping debris, and 205 tires. Additionally, the Pima County Summer Youth Crew removed several 40-cubic-yard dumpsters of trash from the District's Black Wash properties (Figure 12).



Figure 12. Removing illegally dumped trash from Black Wash floodplain (July 3, 2018 photo).

6.4.3.2 Northern Altar Watershed Area Project

Pima County's Northern Altar Valley Watershed Area (NAWA) is a large-scale landscape restoration project aimed at restoring ecological function, native plant cover, and hydrological function on abandoned and degraded agricultural lands on the County's King 98 Ranch. Begun in 2016, this project has so far consisted of two phases, the latter of which is planned for completion in 2019. Collaborating with the Altar Valley Conservation Alliance and the USFWS Partners for Fish and Wildlife program, Pima County has created a series of low dirt berms and installed erosion-arresting rock structures, as well as plowing and seeding with native plants on the upstream edges of the berms. Key successes of this restoration site thus far indicate that the capture, storage, and release of sheet flow was improved, soil erosion was reduced, and native plants responded favorably. During 2018, County staff strategically planted 188 plants from Pima County's Native Plant Nursery to further bolster revegetation of the site. Additionally, County staff worked with the Arizona Conservation Corps to remove invasive vegetation from the site (Figure 13).



Figure 13. Pima County partnered with the Arizona Conservation Corps to remove invasive weeds on the King 98 Ranch agricultural land restoration site. During two weeks in October-November 2018, the Conservation Corps team removed 268 bags of weeds.

Pima County has also partnered with Dr. Joseph Blankinship, a soil biogeochemist from the University of Arizona's Department of Soil, Water, and Environmental Science to test the

potential value of compost and biochar, a charcoal-like substance that is used as a soil amendment, to facilitate native perennial grass establishment and enhance soil health. In 2018, Dr. Blankinship and his lab installed, fenced, and seeded a full factorial design of research plots (in a randomized block design) on a small portion of the NAWA site to study the utility of compost, seeding, and biochar as a landscape restoration tool in the Sonoran Desert. Soil and vegetation assessments will be done annually for five years and will benefit landscape restoration efforts in the Sonoran Desert.

6.4.4 Open-space Infrastructure Mapping

Pima County is using GPS units to map infrastructure and camping use on all of the County's properties, in particular the ranch properties. Four of the County's ranches—including Bingham Cienega Natural Preserve—have been completed thus far. To accommodate this new information, NRPR created a geo-database and standard operating procedures for the collection, storage, and mapping of this information, which is used in development of coordinated resources management plans (see section 5.2 of the MSCP) and to inform the placement of long-term monitoring plots for vegetation and soils (see Appendix Q of the MSCP).

6.4.5 Off-Highway Vehicle Management

Management of off-highway vehicular traffic is a continuing issue. Short-term strategies include specific treatments to prevent OHV abuse of potential mitigation lands and other open space properties (Figure 14). Long-term strategies include planning for motorized vehicular uses on County-owned parcels and ongoing inventories of trails, roads, and campsites on ranches.



Figure 14. Installation of cable and post to prevent OHV access at an open space property along the Pantano Wash (photo date 12/20/2018).

6.4.6 Water Rights Management

Pima County has a policy of managing water rights on County land and to do this, Pima County has a process to assure that water rights are transferred to the County or RFCD upon acquisition of a property.

Pima County is also participating in the adjudication of water rights in the Gila River watersheds, along with many other parties in the state. The San Pedro watershed is being adjudicated first. The Sands and the Clyne ranches, County-owned MSCP lands, are located at the very top of the Babocomari watershed, a major tributary to the San Pedro River. In 2017 and 2018, the Special Master accepted corrections proposed to the records for stockwatering claims.

The affected claims have now migrated from their former status as “claims”, to their present status as water rights proposed by the Special Master for confirmation in the Gila Adjudication. While this is a favorable development, it needs to be mentioned that there are tens of thousands of other such claims that the court needs to address before anything approaching a final decision can be expected.

For the claims we own in the San Pedro River watershed and the Santa Cruz River watershed, efforts are ongoing to correct the location, the claimed uses, and the consumption data at sites where historic claims affect MSCP lands in the Edgar, Buehman, and Peck watersheds, and along the San Pedro mainstem. Pima County will continue to protect our water rights at Bingham Cienega and other potential mitigation lands in the San Pedro watershed through participation in the San Pedro Adjudication, and through appropriate filings in the Gila Adjudication with ADWR and the Maricopa County Superior Court. The County Attorney's Office monitors new requests for surface water appropriations for threats to the County's own water rights, and continues to research the availability of additional pre-Statehood water rights claims to bolster the County's legal standing in the Adjudication.

6.4.7 Adaptive Management

No reported actions

7 Monitoring

The Pima County Ecological Monitoring Program (PCEMP) is a key requirement of the MSCP and while it officially began at the time of permit issuance, many of the elements within this program have long received some degree of monitoring or data collection as important parts of Pima County's Sonoran Desert Conservation Plan (SDCP). The PCEMP's goals include monitoring a variety of parameters that are covered by five basic themes-- species, habitat, landscape pattern, threats, and climate. The MSCP is structured such that the many elements covered by the PCEMP are rolled out in a phased approach. A primary focus during the first few years includes completing first rounds of species monitoring, continuing with basic inventories of County preserves, setting up long-term soils and vegetation monitoring plots (i.e., habitat monitoring), and concentrating on water resources monitoring at springs and streams. The below sections highlight these and other elements accomplished by the PCEMP in 2018.

7.1 Property Inventories and Assessments

County staff continued preserve land property inventories and assessments in 2018, particularly while evaluating the distribution of Sonoran desert tortoises across County lands in advance of the first round of tortoise monitoring during the 2018 monsoon season. During these property assessments, staff record incidental observations of species of interest, threats, infrastructure issues, or other features of interest. Observations related to threats or resource damage were passed along to the appropriate Pima County managing department.

Pima County staff performed 99 individual visits to 31 properties from January through December 2018 (Figure 15). Staff visited Tucson Mountain Park more than any other property, due to Sonoran desert tortoise monitoring efforts (N=43). A key feature of property inventories was the collection of observations on Covered Species. Towards this end, staff made 1,193 separate observations, of which 427 (36%), 304 (25%), and 257 (22%) were of Sonoran desert tortoise, needle-spined pineapple cactus, and Pima pineapple cactus, respectively (Table 5). Staff made observations on 18 of the 32 (56%) vertebrate and plant Covered Species. The Sonoran desert tortoise and the rufous-winged sparrow were found at the most preserves (Table 6; N=11).

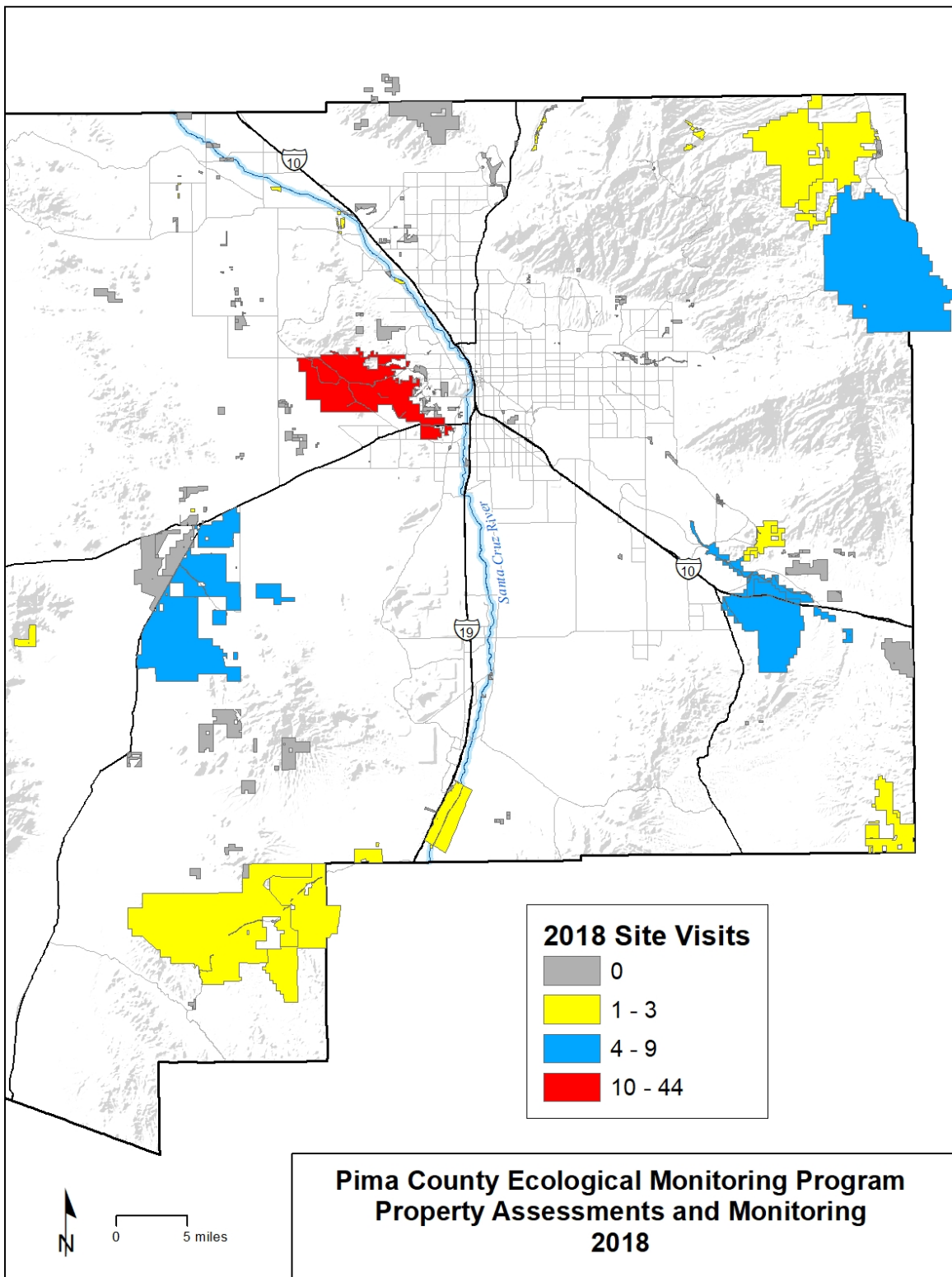


Figure 15. Number of property site visits in 2018 by PCEMP staff. Visits made by other Pima County staff are not reported here. Tucson Mountain Park was visited 43 times during tortoise monitoring efforts.

Table 5. Number of observations of Covered Species, 2018. For many species, the number of observations does not correspond to the number of individuals; however, those data are recorded. For the Sonoran desert tortoise and talussnail, the number of observations includes both live individuals and sign such as scat and carcasses/empty shells. For, Chiricahua leopard frogs, lowland leopard frogs, fishes, and bats, reported numbers represent the number of occupied sites.

Taxon Group	Species	Number of observations
Plants	Huachuca water umbel	0
	Needle-spined pineapple cactus	304
	Pima pineapple cactus	257
	Tumamoc globeberry	6
Mammals	Merriam's mouse	0
	Lesser long-nosed bat	0
	Mexican long-tongued bat	4
	California leaf-nosed bat	3
	Townsend's big-eared bat	3
	Western red bat	0
	Western yellow bat	0
Birds	Abert's towhee	10
	Arizona Bell's vireo	47
	Cactus ferruginous pygmy owl	1
	Rufous-winged sparrow	65
	Southwestern willow flycatcher	0
	Swainson's hawk	0
	Western burrowing owl	0
	Western yellow-billed cuckoo	8
Fishes	Desert sucker	0
	Sonora sucker	0
	Gila chub	6
	Gila topminnow	2
	Longfin dace	7
Reptiles	Desert box turtle	1
	Giant spotted whiptail	0
	Groundsnake (valley form)	0
	Northern Mexican gartersnake	0
	Sonoran desert tortoise	427
	Tucson shovel-nosed snake	0
Amphibians	Lowland leopard frog	9
	Chiricahua leopard frog	2
Invertebrates	Talussnail species	31
Total observations		1,193

Table 6. Covered Species and Pima County properties where each was found in 2018. Includes only those properties where live individuals were found by either county staff or a partner organization (e.g., Tucson Audubon Society) working on a County preserve.

Species	Property	Species	Property
Mexican long-tongued bat	Buehman Canyon Cienega Creek Natural Preserve Colossal Cave Mountain Park	Sonoran desert tortoise	A7 Ranch Agua Verde Creek Preserve Bar V Ranch Diamond Bell Ranch M Diamond Ranch McKenzie Ranch Marley Ranch Old Hayhook Ranch Rancho Seco Six Bar Ranch Sweetwater Preserve Tucson Mountain Park
California leaf-nosed bat	Rancho Seco Tucson Mountain Park	Lowland leopard frog	A7 Ranch Buehman Canyon Cienega Creek Natural Preserve M Diamond Ranch
Townsend's big-eared bat	Colossal Cave Mountain Park Rancho Seco	Chiricahua leopard frog	Clyne Ranch Sands Ranch
Abert's Towhee	Blanco Wash FLAP MHPERP	Gila chub	Cienega Creek Natural Preserve
Arizona Bell's Vireo	A7 Ranch Buehman Canyon M Diamond Ranch MHPERP Oracle Ridge Rancho Seco Sands Ranch	Gila topminnow	Cienega Creek Natural Preserve
Western yellow-billed cuckoo	M Diamond Ranch	Pima pineapple cactus	Bar V Ranch Diablo Village Estates Diamond Bell Ranch Rancho Seco Sopori Ranch
Rufous-winged sparrow	Cienega Creek Natural Preserve Colossal Cave Mountain Park Diamond Bell Ranch FLAP properties Old Hayhook Ranch Rancho Seco Sopori Ranch Tucson Mountain Park	Needle-spined pineapple cactus	A7 Ranch Bar V Ranch Cienega Creek Natural Preserve M Diamond Ranch Six Bar Ranch
Talusnail species	Buehman Canyon Los Morteros Old Hayhook Ranch		
Tumamoc globeberry	Painted Hills (adjacent to)		

7.2 Covered Species

The MSCP identified species-level monitoring elements for 15 of 44 covered species (see Appendix Q of the MSCP). PCEMP activities during 2018 that were related to these efforts were divided into two categories: 1) initiation of the first round of required monitoring protocols, and 2) collecting further background information necessary to develop future monitoring protocols.

County staff completed the first round of scheduled monitoring for Sonoran desert tortoise, covered bat species (for cave and mine dwelling covered species), and Chiricahua and lowland leopard frogs. Monitoring was delayed for Pima pineapple cactus (PPC) in lieu of additional property inventory efforts to more completely identify areas of high enough population density to include in a distance sampling frame. Lastly, County staff contributed field support to a Sonoran talussnail research effort in partnership with Drs. Aaron Flesch and Hans Werner-Herrmann from the University of Arizona. The following provides a brief summary of findings from 2018 monitoring efforts, along with a progress update for delayed elements such as PPC. Additional information containing full monitoring protocols and results can be found in respective appendices.

7.2.1 Required Monitoring – first round completed

7.2.1.1 Sonoran Desert Tortoise

Between 2016 and 2018, Pima County implemented a broad inventory effort to identify areas of high Sonoran desert tortoise density on County preserve lands in preparation for the first round of scheduled monitoring in 2018. Staff identified significant tortoise populations in the Tucson Mountains, Tortolita Mountains, and the lower San Pedro River valley. In 2018, Pima County implemented the first round of Sonoran desert tortoise monitoring. In consultation with USFWS staff, Pima County determined that using a parameter based on occupancy protocol to monitor tortoise populations on three County properties in the Tucson Mountains (Tucson Mountain Park, Sweetwater Preserve, and Painted Hills Preserve) would be most effective. Occupancy has been broadly used to monitoring Sonoran desert tortoise populations in the surrounding area, and is more cost-effective than monitoring density, thereby allowing for a better local and regional understanding of tortoise population dynamics over the lifetime of the MSCP. Restricting monitoring efforts to the Tucson Mountains allowed for the maximum allocation of time to monitoring rather than travel, thereby allowing for more monitoring plots to be established and for each plot to be visited more times per monitoring season than more remote sites. Additionally, by locating monitoring plots in this area, Pima County is well poised to be able to investigate potential impacts related to nonnative invasive plants and other impacts related to this preserves juxtaposition with the urban-wild interface. Monitoring surveys were implemented during the monsoon season (July – September), with 20 monitoring plots established, each surveyed three times. Forty-two tortoises were detected across all plots with an additional two incidental detections just off of sampling plots. The County's occupancy study design and field sampling protocol are both outlined in more detail in Appendix 7.

We processed (recorded mass, midline carapace length (MCL), etc.) 40 tortoises (including two individuals found just outside of occupancy plots. These included 11 females, 16 males, and 13 juveniles. We found four tortoises on plots and inside of shelter sites during temperatures that

we considered too warm to safely extricate and process them, and these individuals were not marked or processed. Female and male tortoises did not differ in mass or MCL. Consequently, mean adult mass was 2410 ± 101 g and mean adult MCL was 220 ± 4 mm (Fig. XX). On average, juveniles (individuals < 180 mm MCL) were 624 ± 131 g and 126 ± 11 mm MCL. Maximum adult mass and MCL was 260 mm and 3,350 g, while minimum juvenile mass and MCL was 63 mm and 53 g. Eight of the 40 tortoises voided during processing (4 males, 1 female, and 1 juvenile). Two adult tortoises, on two different plots had overt symptoms of a respiratory infection including wheezing and/or wet/crackly sounding breathing. However, only one of these individuals had nasal discharge. An additional nine tortoises showed mild swelling of the eyelids (sometimes associated with some inflammation of the conjunctiva), but these individuals were generally otherwise healthy in appearance with no other evident symptoms of illness.

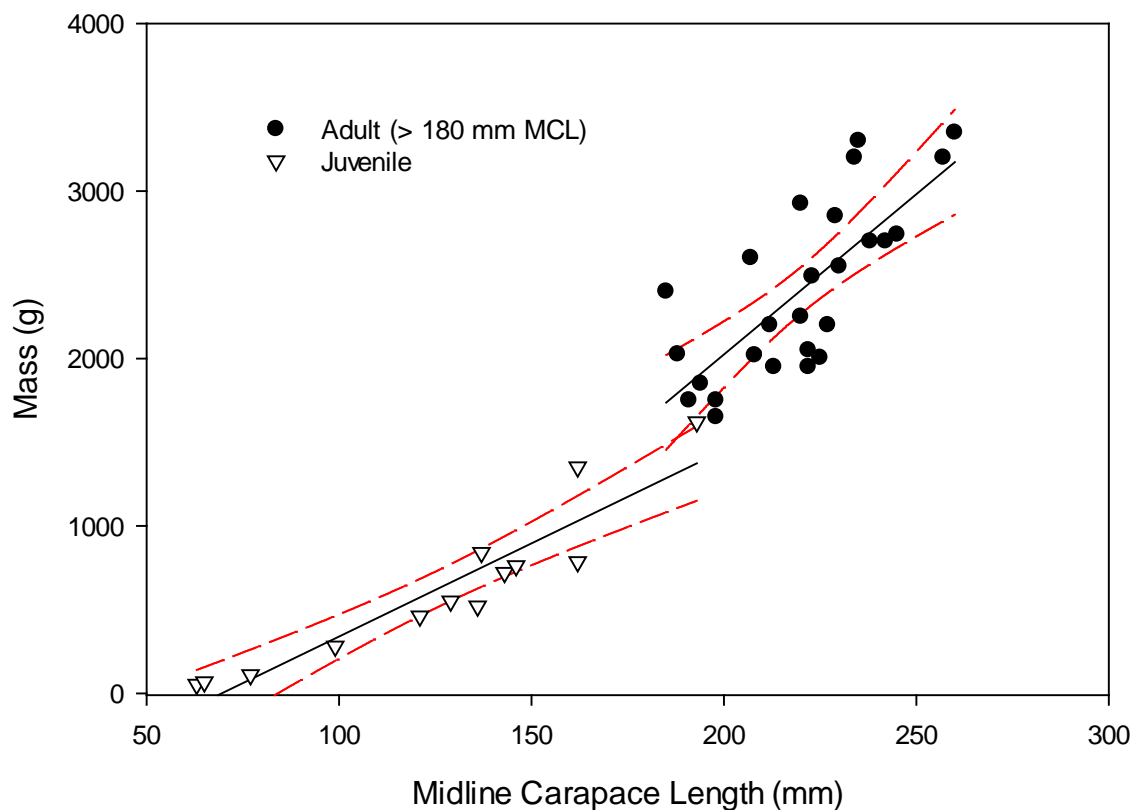


Figure 16. Plotted 95% Confidence intervals on relationship between length and mass for juvenile (< 180 mm MCL) and adult tortoises. Note that we could not sex one individual > 180 mm MCL.

We used program PRESENCE to analyze monitoring data and estimate percent area occupied and detectability. PRESENCE allows users to determine the relative importance of potential covariates on both occupancy and detection. We estimated overall percent area occupied to be 0.62 (95% CI = 0.53 - 0.72) across all top-ranking models. Number of available shelter sites was the strongest predictor of occupancy, with presence of an incised wash and average percent vegetation cover being moderately and weakly predictive. Detection (p) decreased slightly as across survey periods, with $p_1 = 0.71$, $p_2 = 0.67$, and $p_3 = 0.55$. Overall detection was estimated at 0.64 (95% CI = 0.59 - 0.70) across all three entire season. Observer experience strongly

influenced detection, while air temperature during the survey was weakly related. Our estimates of percent area occupied were slightly lower than a comparable study at 0.72 (95% CI = 0.56 - 0.89); however, detection was considerably higher than the estimate from same study at 0.43 (95% CI = 0.33 - 0.52) (Zylstra et al. 2010). We attribute this to a smaller area surveyed within our sampling frame, whereas the prior study surveyed sites in both the Tucson and Rincon Mountains. Additionally, our study had a smaller team of more experienced observers, whereas the prior study had more observers with a larger range of experience levels.

Additionally, tied with the tortoise monitoring efforts in the Tucson Mountain Park and adjacent preserve lands, County staff produced an informative brochure to inform the public about Pima County’s tortoise monitoring efforts and the County’s MSCP (Appendix 8). These brochures will be distributed at various kiosks in Tucson Mountain Park and Sweetwater Preserve.

7.2.1.2 Cactus Ferruginous Pygmy Owl

Pima County collaborated with Dr. Aaron Flesch (University of Arizona) to develop a monitoring program and a habitat suitability model for the cactus ferruginous pygmy owl (CFPO) on County preserves. Dr. Flesch completed the first round of monitoring during 2017, surveying 11 transects three times each for CFPO, resulting in a high of 20 occupied owl territories (see 2017 MSCP annual report). Dr. Flesch’s completed his final report in 2018 discussing the survey results and habitat model (Appendix 9).

7.2.1.3 Bats

The County has committed to regularly monitoring four species of bats at 10 roost sites on County preserves; those species are the lesser long-nosed bat (*Leptonycteris yerbabuenae*), Mexican long-tongued bat (*Choeronycteris mexicana*), California leaf-nosed bat (*Macrotus californicus*), and pale Townsend’s big-eared bat (*Corynorhinus townsendii pallescens*). All four species are cave-dwelling and frequently roost in caves and historic mine features, although there are currently no known lesser long-nosed bat roosts on Pima County preserve lands. Through the Tucson Audubon Society, the County contracted with bat biologist Sandy Wolf to monitor these sites during 2018, with surveys running from May – December, including two visits to most sites. A variety of methods were used depending on the bat species and site, including roost exit counts, internal surveys of mine adits, installation of guano sheets, and eDNA analysis of collected guano. Covered bat species were confirmed to be using at least six of the monitored sites, including a maternity colony of Townsend’s big-eared bats on Rancho Seco, and substantial colonies of southwestern cave myotis at Rancho Seco and Buehman Canyon Preserve (Table 7). An in depth report and protocol will be completed in 2019.

Table 7. Bat species documented at monitoring sites on Pima County preserve lands, 2018.

Site Name	County Preserve	Species Present	Notes
Karen’s Cave Soil Piping Feature	Cienega Creek Natural Preserve	Mexican long-tongued bat	1 and 2 individuals present in May and September
Korn Kob Mine	Buehman Canyon Preserve	Southwestern cave myotis*	Large roost; >1000 individuals
Las Guijas Mine	Rancho Seco	Southwestern Cave myotis**	2 adjacent adits; ~7500 counted exiting in June

Good Enough Mine Complex	Rancho Seco	Townsend’s big-eared bat	4 adits; maternity colony with 50 adults and young
Silver Hill Mine Complex	Rancho Seco	California leaf-nosed bat	2 adits; 24 individuals in September
Arkenstone Cave	Colossal Cave Mountain Park	Mexican long-tongued bat	3 and 5 individuals exiting in May and September
Colossal Cave	Colossal Cave Mountain Park	Southwestern cave myotis and Townsend’s big-eared bat	3 cave entrances; video recorded 502 bats across all entrances; harp trapped 99 cave myotis and 18 big-eared bats
Singleton Mine	Tucson Mountain Park	California leaf-nosed bat	738 individuals in December
Golden Star Mine	Rancho Seco	Southwestern cave myotis***	6 individuals, tentative ID
New Colorado Mine	Rancho Seco	Unknown***	No internal survey due to bees

*This site contains a large roost of southwestern cave myotis and it is not possible to determine if other less numerous species may be using the shaft at the same time.

** This site contains a large roost of southwestern cave myotis (~7,500 counted 9 June 2018) and in the past, small numbers of Townsend’s big-eared bats have also been netted emerging from this site. It was not possible to determine if other less numerous species were using the site using an exit count.

***These sites were selected based on initial survey results made by BLM and Bat Conservation International staff in 2015 that indicated potential presence of covered bat species.

7.2.1.4 Lowland Leopard Frog

The County has committed to monitoring six known lowland leopard frogs (LLF) sites every three years. These sites include Buehman, Bullock, Edgar, Espiritu, and Youtcy Canyons on the east side of the Catalina and Rincon Mountains, and lower Cienega Creek in Cienega Creek Natural Preserve (Figure 18). From previous monitoring efforts, County staff understood that several of these sites were further divided into intermittent wetted reaches during the driest periods of the year. Channel structure, sediment flow, and water availability are dynamic within all monitoring sites, and subsequently occupancy of LLF populations within these reaches are also dynamic. The decision to monitor on a three-year interval is meant to assess long-term site persistence rather than more detailed inter-annual population dynamics.

County staff monitored LLF sites from 7-13 June 2018 in conjunction with annual wet-dry mapping efforts. Surveys consisted of diurnal visual encounter surveys, where one or more observers surveyed first for suitable habitat (i.e. pools, wetted reach, tinajas). Once suitable habitat was identified, observers used binoculars to survey features for all life stages of LLF. Date, time, and length of area surveyed, along with number of LLF observed by life stage (adult, juvenile, larval [tadpole]) are summarized in Table 8 below. Full monitoring protocol and 2018 monitoring results can be found in Appendix 10.

Table 8. Summary lowland leopard frog monitoring results by site, 2018.

Site Name	Reach (Length)	Date Surveyed (Time of Survey)	# Observed (by age class)*
Cienega Creek	12.9 km**	23 March 2018 5 June 2018 18 September 2018 17 December 2018	March: 1 adult June: unidentified frog tadpoles in 3 stretches; 1 unidentified adult/juvenile*** September: 4 adult/juveniles in 3 different stretches December: ~120 tadpoles in one pool
Buehman Canyon	Upper (2.02 km)	12 June 2018 (42 min)	None
	Lower - upstream (3.03 km)	12 June 2018 (47 min)	200 tadpoles
	Lower - spring (1.24 km)	12 June 2018 (39 min)	110 juvenile, 905 tadpoles
	Lower - tinajas (1.9 km)	12 June 2018 (123 min)	28 juvenile, 253 tadpoles
Bullock Canyon	N/A (1.5 km)	12 June 2018 (117 min)	60-100 juvenile, 150-200 tadpoles
Edgar Canyon	N/A (0.5 km)	13 June 2018 (51 min)	1 adult, 86 juveniles, 420 tadpoles
Espiritu Canyon	Upper (3.8 km)	7 June 2018 (120 min)	None
	Lower (1.83 km)	7 June 2018 (136 min)	2 juvenile, 250 tadpoles
Youtcy Canyon	Spring (1.08 km)	12 June 2018 (94 min)	10 adult, 220 juvenile, 1,050 tadpoles

*Numbers of tadpoles and juvenile leopard frogs are estimates.

**The length of stream that is monitored during quarterly wet-dry mapping efforts.

***A number of unidentified ranid frog tadpole observations were recorded, while they were not confirmed to be lowland leopard frog tadpoles, bullfrogs are not currently reproducing in the creek channel and given the approximate tadpole size and the confirmed leopard frog tadpoles in nearby or similar sites by PCEMP surveyors, these observations are likely of LLF.

7.2.1.5 Chiricahua Leopard Frog

Pima County committed to monitoring any sites where Chiricahua leopard frogs (CLF) establish on an annual basis for the first three years followed by every three years thereafter (Figure 18). Chiricahua leopard frogs naturally recolonized Hospital Tank on the Clyne Ranch in September 2016, and have been regularly monitored by David Hall, University of Arizona wildlife biologist, since then. Pima County staff also monitor this site annually using the USFWS-approved visual survey protocol and datasheet. During June of 2018, County staff confirmed the presence of 21 juvenile and adult CLF (including one calling male), as well as many large tadpoles which were likely a combination of CLF and bullfrog tadpoles (tadpoles were not captured for confirmation). David Hall and his team regularly monitor this site for nonnative bullfrogs and have repeatedly made efforts to eliminate this species whose presence presents an impediment to CLF population establishment at this site. Despite repeated efforts in 2017, bullfrogs successfully bred in Hospital Tank late in 2017, resulting in 316 large bullfrog tadpoles observed on 23 May

2018. On this same date, 44 adult CLF and 105 CLF tadpoles were observed, along with one adult bullfrog (David Hall, personal communication).

David Hall and his team of biologists continue to monitor this site and remove bullfrogs, but some bullfrog tadpoles survived to metamorphosis during 2018 as demonstrated by juvenile bullfrogs observed in November. Surveys between November and December confirm the presence of juvenile and adult CLF at this site. Nonnative and invasive mosquitofish remain abundant at this site, but there have been no reports of any other nonnative fish, such as green sunfish, which were successfully removed in 2012. Pima County staff will revisit Hospital Tank again in June 2019.

Goat Well Pond, on the Sands Ranch, was created in 2016 as a wildlife water source and potential habitat for the CLF. This site contains permanent water that is supplied from nearby Goat Well. In April 2018, David Hall and his team reported that CLF had colonized this site, located about 3.2 km from Hospital Tank. During nocturnal surveys of this site, Hall and his team observed a maximum of 21 adult CLF at this site (David Hall, personal communication). County staff visited Goat Well Pond in June 2018, and observed at least nine confirmed or likely CLF, including two calling males, one large female, and one CLF egg mass (Figure 17). Bullfrogs have not been detected at this site, and David Hall's team continues to monitor this site for bullfrog presence; if they are detected they will be removed. Pima County staff will revisit Goat Well pond in June 2019. Full monitoring protocol and 2018 monitoring results can be found in Appendix 10.



Figure 17. Chiricahua leopard frog egg mass in Pima County's constructed Goat Well Pond, Sands Ranch, June 2018.

7.2.1.6 Southwestern Willow Flycatcher

Pima County Staff completed the first round of monitoring for the Southwestern Willow Flycatcher (SWFL) on Bingham Cienega and Cienega Creek Natural Preserves in 2017 utilizing the USFWS-approved call playback survey protocol (Sogge et al. 2010), and results from that monitoring effort were first included in the 2017 MSCP Annual Report. The final Southwestern Willow Flycatcher Monitoring Protocol is included as Appendix 11 of the 2018 MSCP Annual Report.

7.2.1.7 Western Yellow-billed Cuckoo

Pima County Staff completed the first round of monitoring for the Western Yellow-billed Cuckoo (WYBC) in 2017, utilizing the USFWS-approved call playback survey protocol (Halterman et al. 2015). Staff implemented full survey protocols on Bingham Cienega and Cienega Creek Natural Preserves, and exploratory surveys on Lower Buehman Canyon, Edgar Canyon, Posta Quemada Canyon, and Davidson Canyon; results from that monitoring effort were first included in the 2017 MSCP Annual Report. The final Western Yellow-billed Cuckoo Monitoring Protocol is included as Appendix 12 of the 2018 MSCP Annual Report.

7.2.2 Required Monitoring – data acquisition and monitoring plan development

7.2.2.1 Pima Pineapple Cactus

Pima County staff proposed using distance sampling to monitor Pima Pineapple Cactus (PPC) populations after completing a pilot project with Dr. Aaron Flesch (University of Arizona) that confirmed the utility of this monitoring method. However, County staff had not yet identified enough areas with suitable densities of PPC on County preserve lands to meet the statistical assumptions of distance sampling. Consequently, instead of the first round of PPC monitoring that was to begin in 2019, USFWS staff approved Pima County's request to continue to complete inventories of PPC populations on County preserve lands through 2018 and 2019 (S. Richardson, personal communication, 29 January 2018). These efforts will inform the construction of the PPC monitoring sampling frame from which randomly selected distance sampling plots would be selected and monitored. During 2018, County staff surveyed several areas across four County ranch properties (Diamond Bell Ranch, Rancho Seco, Sopori Ranch, and Bar V Ranch) totaling approximately 110 hectares surveyed (276 km x 40 m wide belt transect) and approximately 205 new cacti identified. These surveys represent a large majority of the known PPC habitat on Pima County managed lands, however several more surveys are planned in spring 2019 to fill in areas that were missed. These efforts will lead to a strong monitoring program for PPC when the first round of monitoring is implemented in 2022.

County staff have also developed a draft PPC condition monitoring rubric to assess the general health condition of individual cacti in a repeatable and quantitative manner (Appendix 13). Current survey efforts have yielded qualified descriptions of condition (i.e. "excellent", "good", "fair", and "poor"), whereas this rubric will be quantitative in nature. This effort is useful for assessing general health of PPC during incidental observations as well as those that are monitored regularly (i.e. PPC mitigation banks and distance sampling plots). Using this methodology, the status of individuals that are revisited regularly may be tracked and

compared, and other managers could potentially use this condition assessment allowing for more comprehensive and directly comparable estimates of PPC trends over time.

7.2.3 Species Monitoring Not Required

7.2.3.1 Talussnails

Pima County has collaborated with University of Arizona researchers Dr. Aaron Flesch and Dr. Hans Werner-Herrmann in the form of in-kind match contributions of field surveys to better understand the distribution and biogeography of talussnails, 12 species of which are covered under the MSCP. Their recently funded grant, titled “Status, distribution, habitat, and stressors of the Sonoran talussnail” seeks to better understand the species status of the Sonoran talussnail, an MSCP-covered species that is also currently under review for potential listing by the USFWS. Any field surveys that County staff complete for talussnails on County preserves will follow the survey protocol used by Drs. Flesch and Werner-Herrmann and the AZGFD, which facilitates direct comparisons of data. During 2018, the project PIs trained County staff in their talussnail survey protocol and County staff completed 14 talussnail survey protocols, resulting in documenting 11 live talussnails and approximately 200 empty talussnail shells.

County staff also analyzed the site specific environmental characteristics (such as slope, aspect, and solar radiation) of more than 800 talussnail observations (empty shells) found across County lands, which culminated in an oral presentation at the 2018 Madrean Conference. This bi-national conference, hosted by Sky Island Alliance, brought together over 300 scientists, researchers, and conservationists, primarily from southeastern Arizona and northern Mexico. Key results included the finding that talussnail habitat is highly variable across sites/mountain ranges including the finding that the aspect of sites where snails are observed varies by mountain range and that in some cases snails are predominantly observed on southerly or southeasterly aspects (a common assumption is that talussnails are primarily restricted to cooler, more northerly aspects). Additionally, in some, but not all cases, areas where talussnails are observed receive significantly less solar radiation than other, nearby sites. This work contributes to the development of a better understanding of what is and is not talussnail habitat, and may result in an enhanced ability to assess any potential development-related impacts to these organisms as well as inform management efforts for this species group.

7.3 Habitat Monitoring

All species rely on their associated habitat to persist and thrive; therefore, changes in the structure or function of those habitats are likely to subsequently affect associated species. The MSCP identified several habitat elements suited for long-term monitoring: vegetation and soils, surface and groundwater resources, caves and mines, and talus deposits. These elements represent many of the habitats utilized by MSCP covered species. Therefore understanding how these habitat resources change over the lifetime of the MSCP may inform the species populations trends observed through the County’s species-monitoring efforts and may also be an index for the status of other species which the County does not have explicit monitoring efforts.

7.3.1 Long-term Vegetation and Soils Monitoring Plots

In 2018, the County continued its collaboration with the National Park Service's (NPS) Sonoran Desert Inventory and Monitoring Program and Tucson Audubon Society (TAS) to establish 20 new vegetation and soils monitoring plots. This adds to the 24 plots that were completed in 2017 for a total of 44 and puts the County slightly ahead of its targeted plan to set up 20 monitoring plots per year for the first five years (Figure 18). The partnership between the County, NPS, and TAS to implement the vegetation and soils protocol has been working well, and we expect future years to follow suit. During 2019, the County and NPS will use a power analysis to assess the first two years of data and determine if changes to the proposed number of plots per strata (strata are based on elevation and the rock content of soils) are warranted.

7.3.2 Perennial Water Sources

Perennial surface waters and their associated riparian vegetation make up a relatively small area across Pima County preserves, but are critical to maintaining ecologically functioning landscapes with their complete suite of native flora and fauna (including many of the MSCP covered species), a key goal of Pima County's Sonoran Desert Conservation Plan.

Pima County has long monitored the status of these water sources, during the hottest and driest period of the year before the onset of the summer monsoons. For example, in collaboration with the Pima Association of Governments, Pima County has been tracking surface water at the Cienega Creek Natural Preserve since the 1980s. These efforts continued during 2018, a time of exceptional to extreme long-term drought, according to U. S. Drought Monitor classifications.

Pima County expanded this monitoring effort starting in 2011 to incorporate monitoring of unsupplemented surface water on other County preserve lands on an annual basis. Pima County biologist Brian Powell recently completed a report summarizing these annual wet-dry mapping efforts between 2011-2017 (Powell 2018; Appendix 14). Across Pima County's open space lands, 20 sites that were visited in at least two different years (most sites were visited each year) had surface water on each visit during the hottest time of the year. These sites included five stock tanks, six springs, and nine streams, features that are important to many of the species covered by the MSCP. In cooperation with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service, Pima County has been working on an aquatic and riparian species management plan to guide aquatic species stewardship efforts including the maintenance and potential translocation of aquatic and riparian species, which will be forthcoming in 2019.

7.3.3 Shallow Groundwater

The Pima County Regional Flood Control District (RFCD) has a long history of monitoring shallow groundwater, starting first with the Cienega Creek Natural Preserve and now expanded to six shallow groundwater areas in eastern Pima County and producing results in annual reports (Appendix 15). Future reports will continue to support the MSCP monitoring objectives for assessing depth to water in select shallow groundwater systems, as outlined in Appendix Q of the MSCP.

7.3.4 Cave, Mine and Adit Inventory

All cave and mine features visited as part of the County's 2018 bat species monitoring element were assessed as to their condition and for any potential management needs. The final bat monitoring report will be issued in 2019, but already these efforts have led to the identification of and potential implementation of improvements or repairs to bat-friendly gates at two sites. All sites will be revisited in three years along with the second round of bat species monitoring. Any changes in documented site conditions from the initial inventories will be addressed as appropriate.

In addition to on-site condition inventories, County staff are consolidating all available data on cave and mine feature locations across all County conservation lands. Due to multiple land ownerships within County conservation lands, these records had not been previously consolidated. This comprehensive record of cave and mine features will allow for County staff to inspect them for bat occupancy as time allows.

7.4 Threats Monitoring

7.4.1 Invasive Species

PCEMP staff report on the occurrence and location of a variety of invasive plants including buffelgrass, fountain grass, African sumac, natal grass, and others. In 2018, PCEMP staff made 106 observations and follow-up reports to County managers of these and other invasive plants. Staff also report on invasive aquatic animal species, including American bullfrogs, which could negatively affect covered species populations if not promptly addressed. Efforts to streamline incidental species observations (see section 7.6.1) have allowed for more expedient reporting of emerging invasive species observations to the appropriate management staff.

7.5 Other Monitoring Elements

In addition to required species and habitat-related monitoring efforts, County staff made progress on additional elements described below:

7.5.1 Geodatabase Development

PCEMP staff acquired two ruggedized, GPS-enabled Panasonic Toughpad tablets and implemented the first monitoring protocol with exclusively digital data collection (Sonoran desert tortoise monitoring) in 2018. These tools have allowed field staff to increase the efficiency of field data collection and data quality control.

Additionally, Pima County IT staff have designed an interdepartmental incidental observation database designed to readily share observations (i.e. threats, infrastructure issues) from field staff with the appropriate managing departments. For example, field staff may observe a downed livestock fence, record that data point using the tablet, and the County range program manager will be automatically notified once the data are synchronized. Additionally, staff from other departments may observe MSCP covered species, record that data point, and PCEMP staff will be automatically notified about that observation. This tool has the ability to increase efficiency in geospatial data management, as well as allow for immediate notification of appropriate management staff that may limit the potential impact to resources.

7.6 Science and Technical Advisory Team

The PCEMP Science and Technical Advisory Team (STAT) met in spring of 2018 for a half-day field trip to Cienega Creek Natural Preserve. One goal with STAT is to have all seven members not only be experts in species/landscape monitoring but to also be familiar with the County conservation lands. Discussions during the field trip revolved around upcoming monitoring elements for 2018 (monitoring protocols and field efforts) along with how STAT members would prefer to interact with PCEMP staff. Additional discussions centered on potential collaborations between the County and other conservation partners as well as outreach opportunities involving the PCEMP.

STAT reviewed all species-level monitoring protocols submitted with the 2018 annual report (Sonoran desert tortoise, Chiricahua and lowland leopard frogs). Several future PCEMP monitoring elements will require further STAT discussion, such as the most appropriate monitoring interval for Sonoran desert tortoise and questions related to the construct the PPC sampling frame and allocation of monitoring transects.

7.7 Non-MSCP Covered Species

7.7.1 Arizona Eryngo

In 2018, County staff evaluated an effort to restore a rare wetland plant, the Arizona Eryngo (*Eryngium sparganophyllum*), to Agua Caliente Park, where it historically occurred (Fonseca 2018; Appendix 16). While nursery propagation of this species has been successful at Pima County's native plant nursery, the first transplants suffered from placement in inhospitable sites, and from depredation by javelina. A new effort is underway to test additional transplant sites at Agua Caliente Park, and transplanted Arizona eryngo are being monitored by a local high-school student.

Additionally, Pima County Regional Flood Control District (RFCD) has granted permission to Dr. Max Li Yue (University of Arizona) to study the life history and population structure of this plant on property owned by the RFCD (one of the two known wild populations in the United States), under the terms of a USFWS Section 6 grant to Dr. Li. This project will provide information important to the conservation and management of this plant species, including its status on RFCD land. The RFCD is also considering establishing populations of Arizona eryngo in other areas of suitable habitat on RFCD land.

7.8 Changes to PCEMP Protocols and Timing

7.8.1 Southwestern Willow Flycatcher

Pima County had agreed to monitor for the presence of the southwestern willow flycatcher (SWFL) every three years, at three sites on County lands, including Bingham Cienega Natural Preserve, Cienega Creek Natural Preserve, and at parts of the A7 Ranch adjacent to the San Pedro River (Pima County 2016). However, leading up to Pima County's first round of monitoring for SWFL in 2017, Pima County staff in consultation with USFWS staff concluded that there was no potential breeding habitat for SWFL on the A7 Ranch, and that it was appropriate to drop this site from the County's monitoring commitments. After Pima County's

first round of monitoring for SWFL, the County concluded that there was no longer any suitable habitat for this species at Bingham Cienega due to long-term drying of the riparian habitat. Pima County's request to drop Bingham Cienega as a SWFL monitoring site has been approved by USFWS staff (S. Richardson, personal communication, 13 December 2018), on condition that this that Pima County must evaluate riparian habitat at least every three years at Bingham Cienega and pending any return of habitat suitable for SWFL, the County must resume regular monitoring for this species at this site. Pima County will continue regular monitoring for SWFL at Cienega Creek Natural Preserve as identified prior to this change.

7.8.2 Bat Monitoring Protocol

Pima County has agreed to monitor the roost site condition and occupancy of the MSCP covered bat species including the lesser long-nosed bat, California leaf-nosed bat, Townsend's big-eared bat, and Mexican long-tongued bat at ten roost sites (combined, for all of these species) every three years. The County has contracted through the Tucson Audubon Society for bat biologists Sandy Wolf and Dave Dalton to complete this monitoring and protocol development. The fieldwork has been completed and more than ten sites have been inventoried, many of them more than once. The monitoring results and protocol will be completed in 2019, approximately a year behind the original schedule.

7.8.3 Precipitation Monitoring Protocol

Pima County had agreed to complete a protocol for collecting precipitation across County lands within two years of the County's Section 10 permit. Pima County staff have investigated new and less expensive ways to collect rainfall data as well as ways to host and visualize collected precipitation data using an app developed by Dr. Michael Crimmins and his team at the University of Arizona (myRAINgelog, <https://myraingelog.arizona.edu/>). Additionally, the PCEMP is coordinating with the Pima County Range Monitoring Program to explore ways to leverage already existing rain gauges on County ranches. However, County staff have not yet developed this protocol, and will be at least another year in completing this element of the PCEMP.

7.8.4 Pima Pineapple Cactus Monitoring

The USFWS has approved Pima County's request to continue assessments of PPC distribution across County lands during 2018 and 2019, in lieu of the County's first round of scheduled PPC monitoring, using distance sampling, that was scheduled to begin in 2019. Consequently, the first round of PPC monitoring will be initiated in 2022. See Section 7.2.2.1.

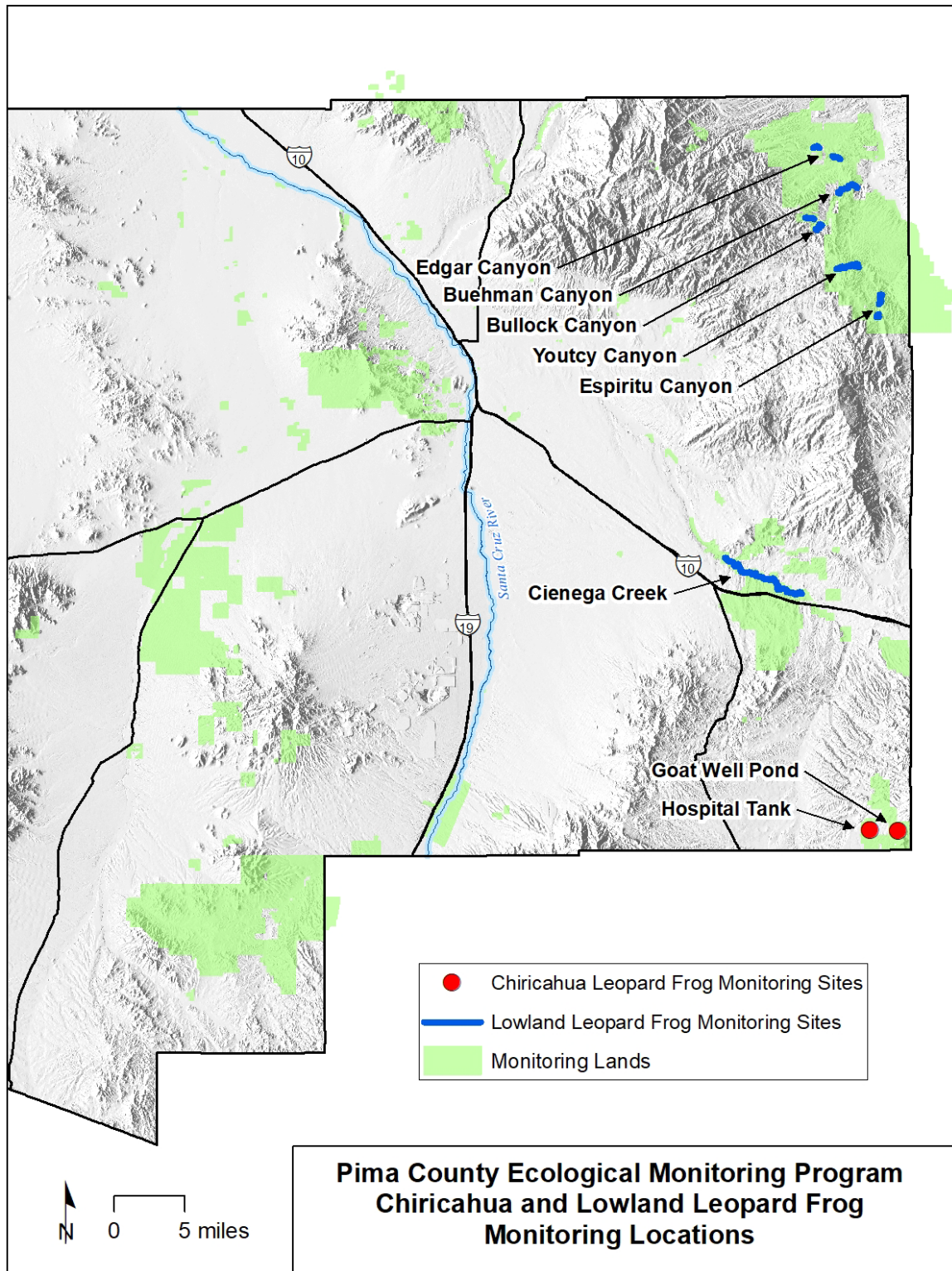


Figure 18. Chiricahua and lowland leopard frog monitoring sites on Pima County Conservation Lands.

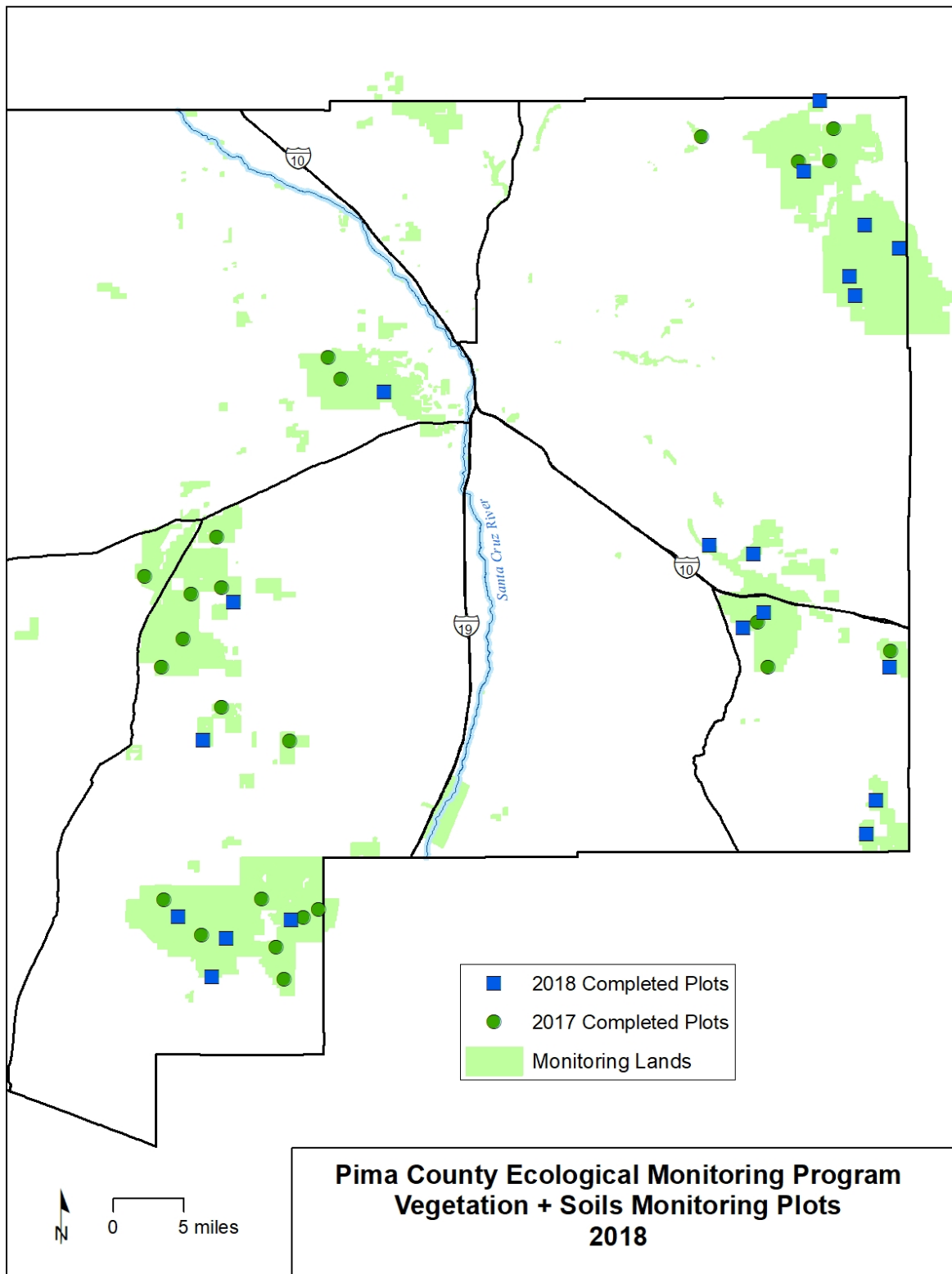


Figure 19. Completed vegetation and soils monitoring plots in partnership with the National Park Service, Sonoran Desert Inventory and Monitoring Network and the Tucson Audubon Society, 2017-2018.

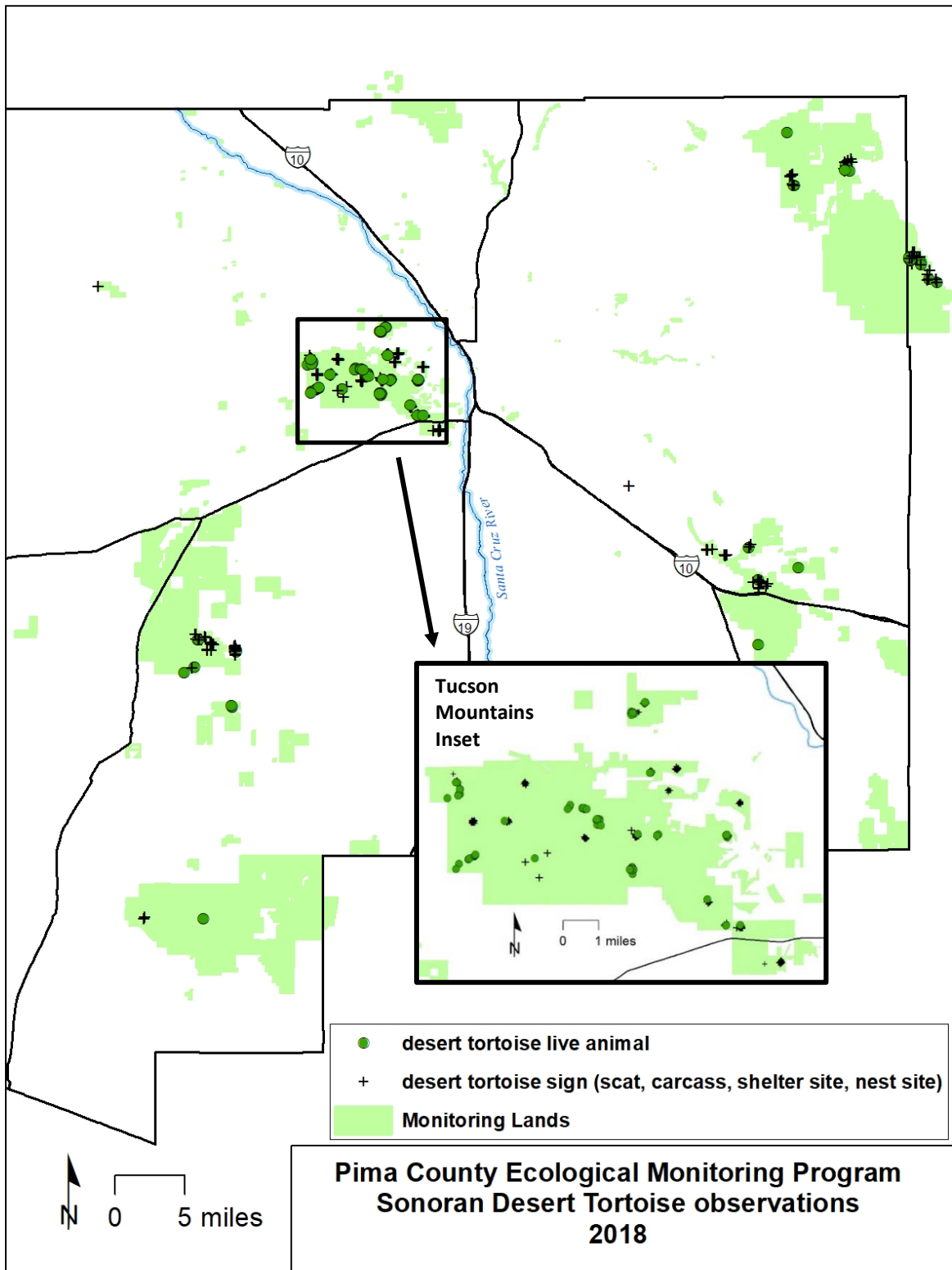


Figure 20. Observations of Sonoran desert tortoise (live individuals and sign) were made on nine properties in 2018, and include observations made during occupancy monitoring on and near Tucson Mountain Park.

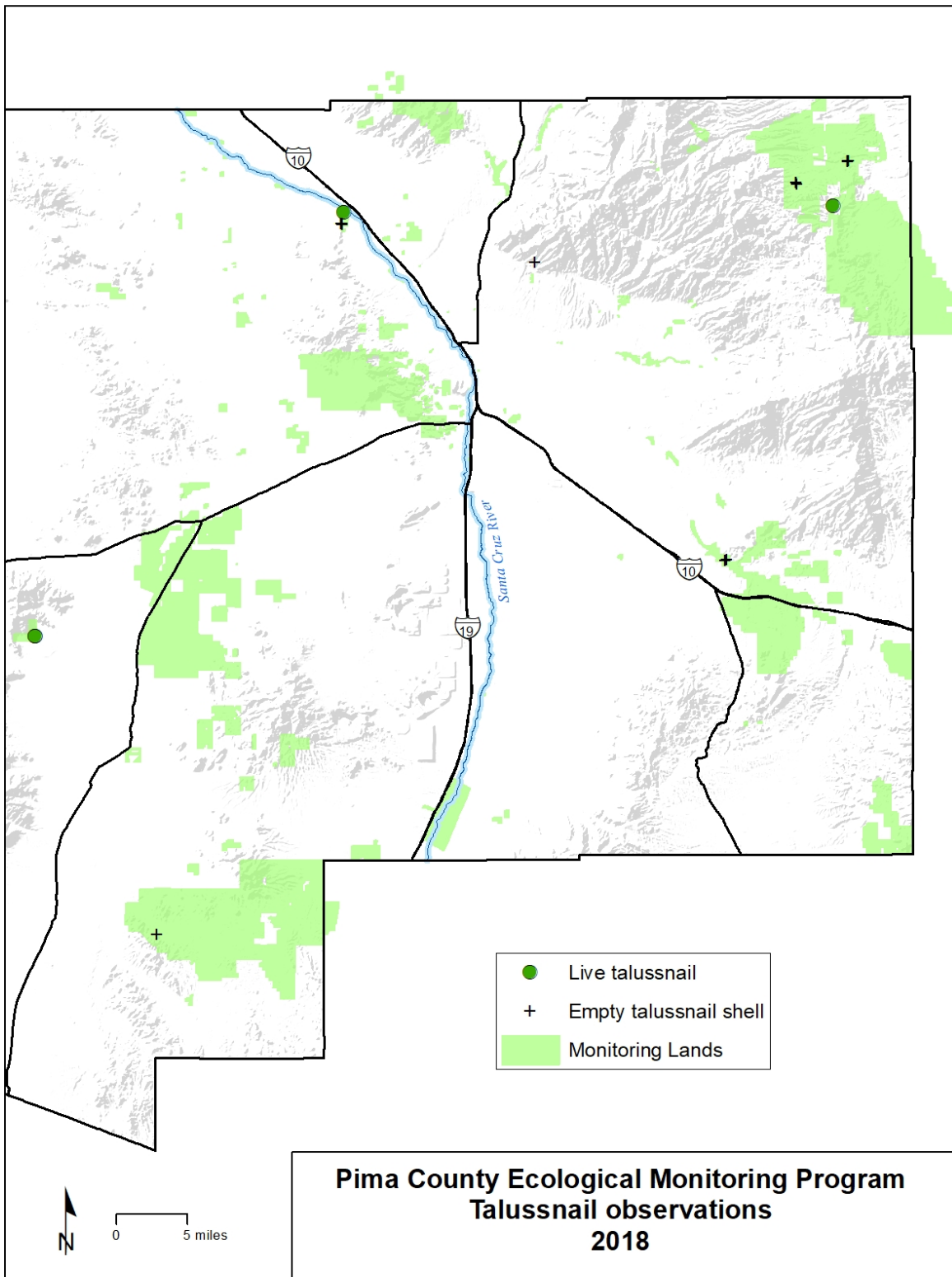


Figure 21. Observations of talussnails on County preserves in 2018. These observations contributed to a research project examining talussnail distributions led by Drs. Flesch and Werner-Hermann from the University of Arizona.

8 Changed or Unforeseen Circumstances

Changed circumstances are scenarios that could affect Covered Species (Table 7.1 of the MSCP) and are differentiated from unforeseen circumstances (Table 7.2 of the MSCP) in that the latter cannot reasonably be anticipated.

8.1 Changed Circumstances

Changed circumstances are those “affecting a species or geographic area covered by a Habitat Conservation Plan (HCP) that can reasonably be anticipated by Plan developers and the [USFWS] and that can be planned for” (50 CFR §17.3).

As discussed with the USFWS Tucson Field Office, we report changed circumstances for the 2018 calendar year (Table 9). In 2017, the Gila topminnow was detected in the Santa Cruz River and confirmed by subsequent surveys in the effluent-dependent stream. Daily discharges of effluent from the two County water treatment facilities have maintained persistent flows along the Santa Cruz River downstream reach, despite the regional drought, but there is no formal allocation of reclaimed water to the river.

Some changed circumstances cannot be fully evaluated until new ecological monitoring programs and reporting mechanisms are underway. In 2016, we listed the reporting frequency for changed circumstances along with the proposed methods of evaluation. A number of changed circumstances determinations will be based on ecological monitoring data for species, vegetation or landscape-related elements.

One example of a changed circumstance that would be evaluated at a later date is vegetation change along the effluent-dependent Santa Cruz River downstream of Tucson, in Pima County. Thanks to monitoring that has been performed by RFCD, we know that length of effluent flow during June has fluctuated from 22.1 miles in 2016, to 21.4 miles in 2017, and 22.3 miles in 2018. According to the Pima County Effluent Generation Report, 2017 effluent discharges were reduced by over 2000 acre-feet from 2016 conditions. Length and volume of effluent discharged to the Santa Cruz River are not the only factors that affect vegetation and other habitat for covered species, but it serves as an indicator. When Pima County implements the landscape pattern monitoring protocol in the upcoming years, we will have a basis for reporting whether a changed circumstances has occurred to the vegetation.

8.1.1 Crayfish and other invasive aquatic species

In 2018, we became aware of crayfish observations in the effluent-dependent Santa Cruz River (Figure 22) downstream of Tucson. Crayfish have not been documented in the CAP canal and consequently this is not likely to be the source for the crayfish in the lower Santa Cruz River.



Figure 22. Crayfish from Marana and Hardin Roads, Santa Cruz River, 2018. Photograph provided by Dr. Michael Bogan, University of Arizona.

In the 2017 MSCP Annual Report, we passed along a report of invasive species in the Central Arizona Project canal. There is no reason to believe that the canal was a source of any new (post-permit) invasive species entering a natural ecosystem. Pima County conferred with Tucson Water regarding quagga mussels due to the 2017 observations of this species in the CAP canal near Red Rock. While Asiatic freshwater clams are regularly observed in Tucson’s Central Avra Valley Recharge Basins, the quagga mussel is not (Dick Thompson, Tucson Water, personal communication to Julia Fonseca). Furthermore, Tucson Water does not discharge raw CAP water into any watercourse.

Neither Asiatic freshwater clams nor quagga mussels have been observed in the Santa Cruz River effluent-dependent reach downstream of Tucson studied by Dr. Michael Bogan and his students in 2017 and 2018 (M. Bogan, pers. comm. to Julia Fonseca). Dr. David Walker, University of Arizona, also reports he has looked for larval-stage molluscs (veligers) in water samples from the effluent-dependent Santa Cruz River as recently as June 2018 with no success.

8.1.2 Desiccation of groundwater-dependent riparian ecosystems

Pima County has been experiencing long-term drought conditions rated as extreme to exceptional according to U. S. Drought Monitor classifications. In the past twenty years, Pima County has experienced a 14 percent decline in precipitation, a deficit of 34.81” of rain. During the same time, annual average temperatures have been increasing, part of the long term trend evident for decades. The four-year period of 2014-2017 ranks as the warmest on record (Pima County 2018, Appendix 17). These drought conditions are not in and of themselves considered

changed circumstances, but may be contributing factors to desiccation of certain groundwater-dependent riparian ecosystems.

In 2017, we presented groundwater data that suggest declining conditions along Sopori Wash and Arivaca Creek. Conditions in ADWR’s monitoring well on Sopori Wash improved in late 2018, probably due to a large flow event that contributed natural recharge (Figure 23). ADWR’s monitoring well at Arivaca Creek did not show considerable difference in water level as compared to 2017 (Figure 24).

8.2 Unforeseen Circumstances

The USFWS did not identify any unforeseen circumstances that affect covered species or their habitats in 2018.

Table 9. Status of changed circumstances during the 2018 reporting period. Because changed circumstances can require management actions, the County’s responses are also included.

Circumstance/Scenario	Occurred during reporting period?	Evidence	If yes, what Response(s)
Invasive aquatic species (crayfish) enter other aquatic sites from non-Central Arizona Project sources.	Unknown but observed during 2018	Photograph	Notified AZGFD. County staff will report future observations. AZGFD currently prohibits the possession and transport of live crayfish (except for in Yuma and part of La Paz County), and only allows use of live crayfish as bait if captured in the same body of water that is being fished.
Delisting of Lesser Long-nosed Bat by USFWS on December 6, 2018	Yes	USFWS announcement	USFWS will circulate a post-delisting monitoring plan for review in 2019
Designation of critical habitat for Sonoyta mud turtle, a species that is not covered under the permit	Yes	USFWS announcement	Limited to occupied habitat in Organ Pipe Cactus National Park, outside the permit area. No action.
State land is conveyed to private sector in Permit Area	Yes	Based on GIS inquiry, see Figure 3	Automatically becomes part of the Permit Area per the terms of the MSCP. See Section 3.1 of this report
Taxonomic changes: new genetic information reclassifies chub species; Tucson shovel-nosed snake confirmed as subspecies <i>klauberi</i>	No	2017 American Fisheries announcement for Chub; Crother et al. 2017	USFWS is evaluating the information; the draft recovery plan for chub is not yet finalized. No change in legal status.

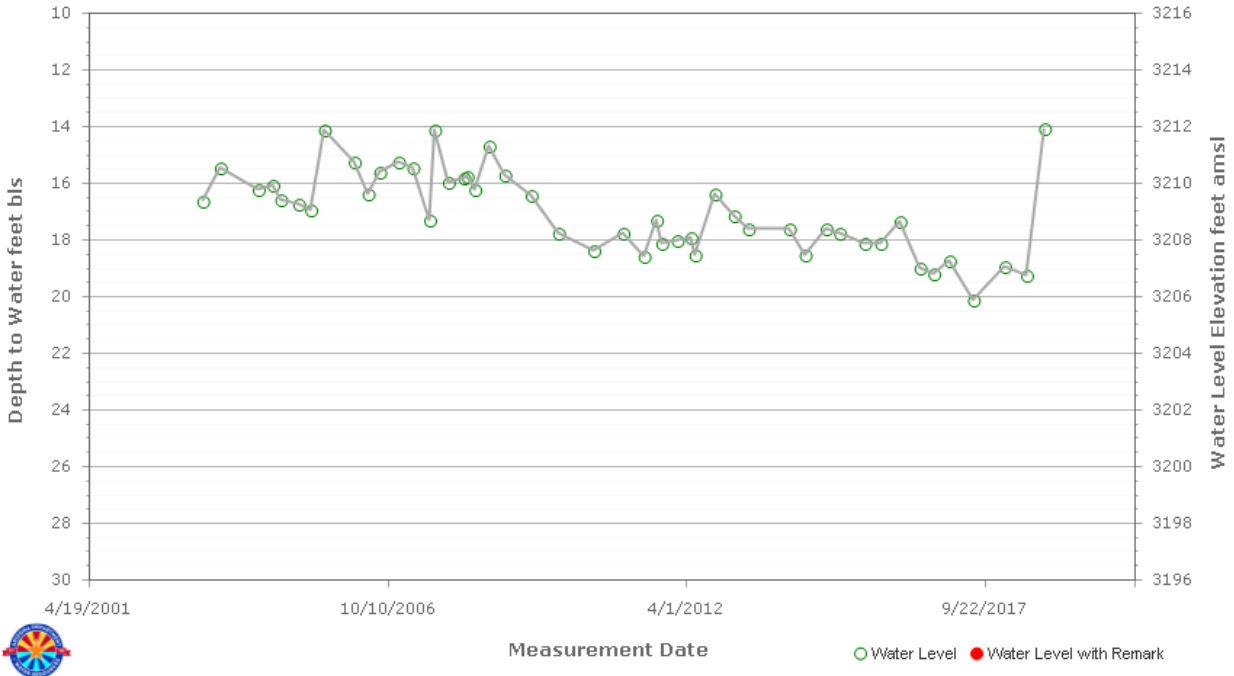


Figure 23. Arizona Department of Water Resources (ADWR) GWSI well hydrograph from Sopori Wash (20-12-05 aac) showing reversal of a declining trend in a portion of Santa Cruz County downstream of Pima County’s Sopori Ranch

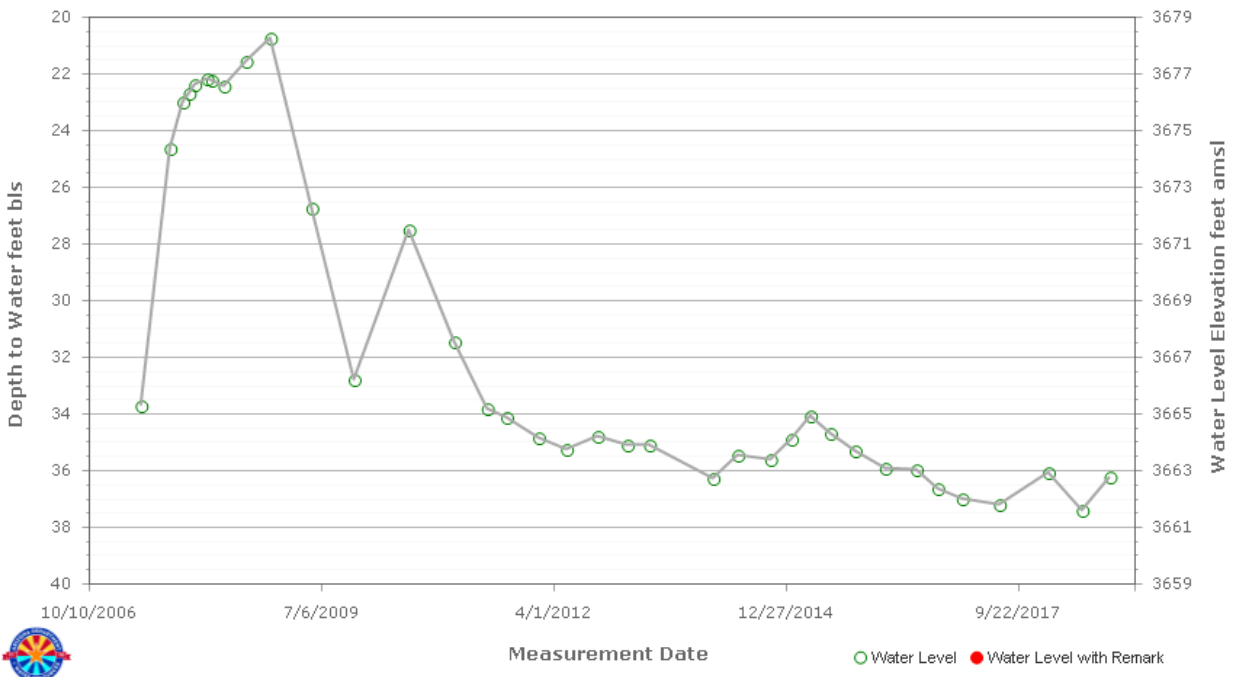


Figure 24. ADWR GWSI well hydrograph from Arivaca Creek (21-10-35ccd) showing a trend that could be causing riparian habitat impacts downstream of Arivaca Lake.

9 Fiscal Year Funding

9.1 Expenditures

Pima County spent over \$3,000,000 in services to implement the MSCP in 2018 (Table 8). Many of these programs existed long before the MSCP and fulfill other County needs, but they are included here because their continued existence contributes to conservation, enforcement, management, monitoring, and administration of MSCP elements. These estimates are based primarily on the percentages of various budget units for the adopted budget for the Fiscal Year ending June 2018, except for the Sheriff’s estimate, which is based on calendar year 2018 visits to potential mitigation land addresses.

Table 10. Estimated expenditure (in thousands of dollars) by County department for avoidance, minimization, management, and monitoring activities in support of Pima County’s Multi-species Conservation Plan, July 2018-June 2019.

Department	Expenditure (thousands of dollars)
County Administrator	77
Communications	0
Development Services	124
Regional Flood Control District	559
Information Technology	75
Natural Resources, Parks and Recreation	1,467
Public Works Administration (Real Property)	230
Sheriff’s Department	24
Office of Sustainability and Conservation	677
Transportation	208
MSCP and Section 10 Program Total	\$3,439

In general, the County funding resources have not materially changed from the estimates provided in Chapter 8 of the MSCP. Two departments, Development Services and Transportation, reported decreased budgets but these do not affect the avoidance and minimization activities they provide for the MSCP.

Highlights from the reporting period for the departments listed in Table 10 include:

- The **County Administrator’s Office** explored options to acquire additional lands in 2018.
- **Communications** helped provide publicity for the Certificate of Coverage program, the Tucson Mountains tortoise monitoring effort, the Tesoro Nueve acquisition, and others.
- **Development Services** continued to administer various avoidance and minimization measures embedded in existing ordinances.
- **Information Technology** department provided assistance in preparing the MSCP and subsequent reporting. This year they substantially completed work supporting ecological data collection.
- **Sheriff’s Department** enforced laws on mitigation lands and provided search and rescue at levels similar to last year

- **Department of Transportation** minimized impacts along roadways using Environmentally Sensitive road design and Environmental Assessment and Mitigation Reports.
- **Public Works Administration** (Real Property staff) worked to acquire several new floodprone lands and donations, and helped with legal protections for the fee-owned mitigation lands.
- **Natural Resources, Parks, and Recreation** (NRPR) manages most of the potential mitigation lands. NRPR created a new position, now filled by Brian Powell, to support Division Manager Karen Simms. NRPR hired Maria Williams, an intermittent range technician, to support the ranch conservation program.
- **Regional Flood Control District** fulfills a key role in minimizing effects on habitat for riparian species and supports management of mitigation land, including the allocated land at Bingham Cienega. This year they provided a new report on shallow groundwater monitoring, and achieved even higher rates of avoidance and minimization.
- **Office of Sustainability and Conservation** supports the land managers with information and monitoring data, and administers the Certificate of Coverage Program. Brian Powell vacated his position in late 2018 to work for NRPR. Cultural resource staff also support management of lands, and this is now reflected in the budget.

9.2 Revenue

The Certificate of Coverage Program has two revenue-generating elements that are applicable only to residential subdivision, commercial, or industrial projects: 1) an Application Fee (\$720.00) and 2) Compliance Monitoring Fee (\$2450.00). When any of the eligible types of residential subdivision, commercial, or industrial projects request a Certificate of Coverage, an Application Fee is collected. Subsequently, a Compliance Monitoring Fee is collected only when the project provides natural open space to be used as MSCP mitigation. For the 2018 calendar year, the Certificate of Coverage Program generated a total of \$1,440.00 in revenue (all of it derived from Application Fee receipts for two residential subdivision projects). Compliance Monitoring Fees were not collected as neither project provided natural open space to be used for MSCP mitigation.

The OSC utilizes these funds to administer the Certificate of Coverage Program, including monitoring of MSCP mitigation land generated through this program.

9.3 Grants

The USFWS's Partners for Wildlife program granted Pima County monies prior to permit issuance of the Section 10 permit for several projects. One grant was for erosion-control work at Peck Spring, a site that until recently, contained lowland leopard frogs (in an associated tank), a Covered Species. There were no new grant monies or received by Pima County or the RFCD since permit issuance that contributed to fulfilling MSCP requirements. However, we benefitted from partnerships with a number of organizations, some of which received grants to improve habitat or monitor species or their habitats. These are described in relevant sections of this report.

10 Other Land Transactions and Processes

In the parlance of the Section 10 permit, mitigation lands are those lands that have been allocated to offset impacts that have already occurred. Other land transactions can affect the pool of lands available to offset future impacts, therefore we report on significant changes here (Figure 21, Appendix 18).

During 2018, several requests to utilize potential mitigation lands were received from outside entities resulting in only one adjustment to the portfolio of potential mitigation lands. A single request led to the removal of 1.15 acres which was authorized by ALWT and USFWS as well as the County Board of Supervisors and Flood Control District Board of Directors.

Additionally, the Pima County acquired the 3,318.3 ac Tesoro Nueve Ranch property and grazing lease on the east side of the Santa Catalina Mountains in June 2018. This property contains the best remaining perennial spring in the Buehman Canyon drainage, and represents the last portion of the drainage that was not yet conserved.

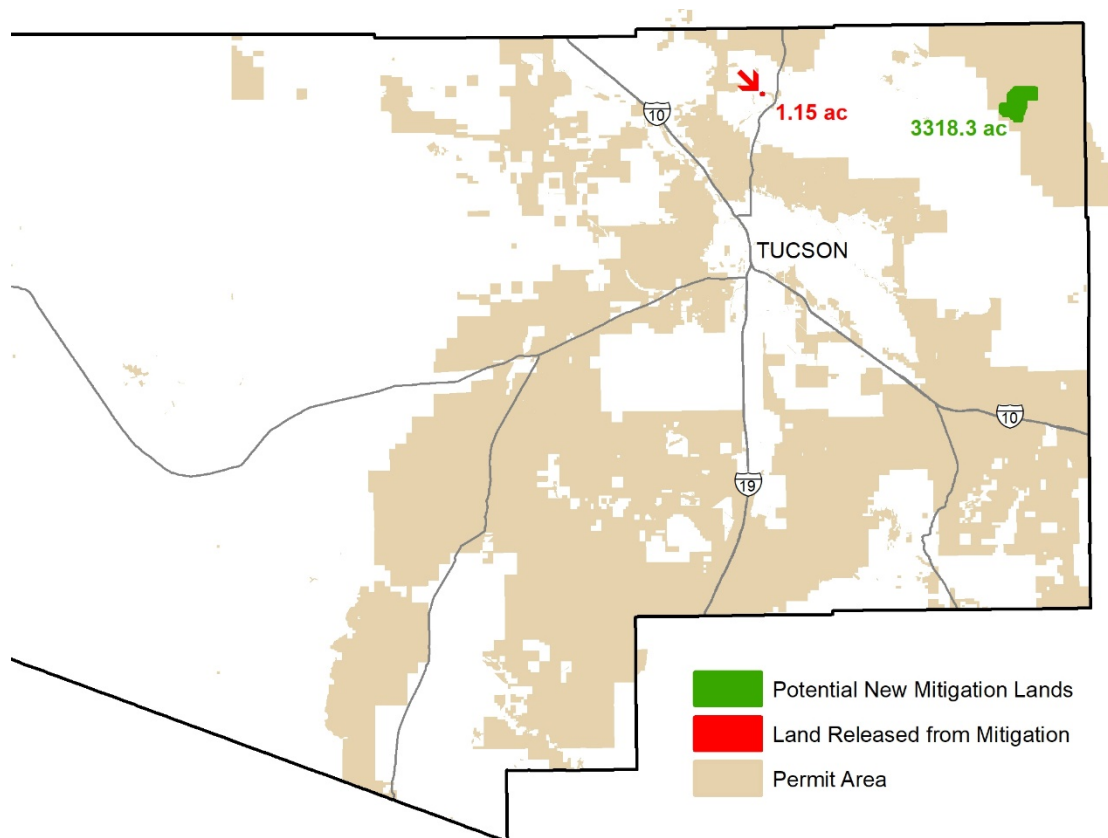


Figure 25. MSCP potential mitigation land acquisitions and releases during 2018.

11 Partnerships

11.1 Arizona Conservation Corps

Arizona Conservation Corps (AZCC) aims to continue the legacy of the Civilian Conservation Corps of the 1930s by connecting youth, young adults, and recent-era military veterans with conservation projects on public lands. Pima County's NRPR has utilized the services of AZCC for a number of years to assist with management of potential MSCP mitigation lands. Local and urban youth from metropolitan areas in southern Arizona work with NRPR staff to construct and repair fences, remove invasive species, plant native species, and clean up wildcat dumps. Pima County open space lands that benefited from the AZCC in 2018, included King 98 Ranch, Bar V Ranch, Bingham Cienega, and Six Bar Ranch.

11.2 Arizona Land and Water Trust

Pima County has an agreement with the ALWT to provide Pima County with third-party beneficiary for both types of restrictive covenants. ALWT evaluated the property inspections provided to them in 2017, and reviewed and approved new additions and the disposal of one property (see Section 10 for details).

11.3 University of Arizona

Pima County is working with Drs. Aaron Flesch and Hans Werner-Hermann (both of the University of Arizona) on a recently funded AZGFD Heritage Fund grant project to survey for and study the habitat of the Sonoran talussnail, as well as other talussnails, on Pima County preserve lands. University of Arizona wildlife biologist David Hall and his crew continue to monitor Hospital Tank and Goat Well Pond on Pima County's Clyne and Sands Ranches, for bullfrogs and other invasive species, and to perform removal efforts as needed. This work is critical for maintaining the Chiricahua leopard frog populations at these sites, the only known ones on County lands.

11.4 Arizona Game and Fish Department

In 2018, Pima County conferred with AZGFD on the potential sites for future native aquatic species establishment for our Aquatic Species Management Plan. AZGFD also evaluated a site in the Buehman Canyon area for Gila topminnow. Pima County participated in discussions with Bureau of Reclamation and AZGFD regarding the impacts of an Interstate 11 alternative. Pima County also continues to facilitate access to AZGFD biologists to monitor the AZGFD-released black-tailed prairie dog colony on Sands Ranch, which is currently thriving and experiencing recruitment.

11.5 Cienega Watershed Partnership and U. S. Bureau of Reclamation

The Cienega Watershed Partnership (CWP) received a grant from the Bureau of Reclamation (BOR) to evaluate potential sites for remediation of erosion or other water quality issues. We worked with CWP and Watershed Management Group (WVG) to evaluate sites in the Cienega Creek Natural Preserve and in Bar V during in 2018. We also printed a "State of the Watershed" summary for CWP.

11.6 The Nature Conservancy

In 2018, Pima County contributed wet-dry monitoring data to the Nature Conservancy's annual San Pedro monitoring effort.

11.7 National Park Service

Pima County continued its cooperative agreement with the Sonoran Desert Inventory and Monitoring Network (SODN) of the NPS, based in Tucson. This allowed the County to leverage a soils and vegetation monitoring protocol for County lands that has been developed by SODN and is currently in use across federal lands managed by multiple agencies near or adjacent to County lands (allowing meaningful comparisons across a larger scope). Additionally, it streamlines collaborations in data synthesis and interpretation, as well as expertise.

11.8 Tucson Audubon Society

Pima County contracted with the Tucson Audubon Society to assist in the implementation of the NPS soils and vegetation monitoring protocols on County lands as well as to monitor and to develop monitoring protocols for cave and mine-dwelling MSCP covered bat species on County preserves. The County benefited from leveraging the expertise and efforts of Tucson Audubon staff who have considerable experience with both of these monitoring efforts.

11.9 Southern Arizona Quail Forever

This organization focuses on quail hunting and quail habitat enhancement in southeastern Arizona and in the past has supported installation of wildlife water sources on Pima County ranches. During 2018, this organization assisted with land restoration activities on the County's King 98 Ranch through invasive plant removal.

11.10 Northern Arizona University

Dr. Clare Aslan, Northern Arizona University is investigating how habitat fragmentation and development may impact the pollination biology and subsequent fruit set, of the Pima pineapple cactus. One of her field sites (representing a site of 'intermediate fragmentation') is RFCD's Diablo Estates property. During 2018, Dr. Aslan documented a single genus of solitary bee visiting cactus flowers at this site (*Diadasia* sp.), and 71% of the tracked flowers set fruit. These results will be compared to PPC pollination biology at other more fragmented sites, as well as at sites with no fragmentation (i.e., Buenos Aires National Wildlife Refuge).

12 Prospective Issues

- Pima County OSC continues to refine a procedure to address requests to utilize County-owned potential mitigation lands for purposes not allowed by the restrictive covenants. The County is consulting with the USFWS and ALWT on those aspects that pertain to potential modification or release of restrictions.
- During 2019, NRPR intends to update park rules for all types of park lands, with public involvement.
- USFWS agreed to consider species enhancement credits for aquatic species establishments but no framework for such credits yet exists.
- USFWS Section 6 monies to acquire species habitat have not yet been authorized by the Administration.
- The USFWS may list Arizona eryngo in future years. While there is no prohibition against take of the plant, it may be desirable to amend the Section 10 permit to include the species if it will enhance the ability of RFCD or its partners to conserve the species or its habitat.
- Pima County is working to minimize the potential impacts of the SunZia power line, the Interstate 11 road corridor, and the Rosemont mine on potential mitigation lands, and to evaluate any relevant information that these projects generate.
- Pima County will continue to respond to AZGFD and others regarding potential native species introductions, such as the black-tailed prairie dogs introduced to Sands Ranch in 2017. An internal procedure for evaluating proposed species introductions of any kind on County lands will be considered.
- USFWS assistance will be needed to continue dialogue with other federal agencies on streamlining their Section 7 consultations in light of the MSCP.
- Pima County continues to operate under a year-to-year agreement for species monitoring and management on State Trust land.

13 Acknowledgements and Certifications

This report is prepared in partial fulfillment of the terms of permit #TE-84356A-0.

This report reflects the continued collaboration of many County departments who provide stewardship to open space lands or provide basic services like information technology, financial reporting, and law enforcement. Our thanks go to the many individuals in the departments who provided assistance: Information Technology; Natural Resources, Parks and Recreation; Sheriff; County Attorney's Office; County Administration; Regional Flood Control District (RFCD); Finance; Transportation; Environmental Quality; Real Property; Office of Sustainability; Health Department; and Public Works Administration.

We are grateful to the Science Technical Advisory Team, AZGFD and USFWS staff for their advice regarding data collection and analysis methods throughout the year. AZGFD and USFWS also provided much useful information on the aquatic species management plan.

We also appreciate the information shared by AZGFD, University of Arizona, Central Arizona Project, Tucson Water, Pima County and RFCD staff, and others for evaluating changed circumstances.

14 Glossary and Acronyms

14.1 Glossary

Adaptive management. Adaptive management is an iterative learning process that identifies gaps in understanding, facilitates action, and modifies management based on new information (Walters 1986). Pima County will employ two types of adaptive management: 1) those decisions for which a single management action is needed (responsive management actions) and 2) decisions that require recurrent actions (recurrent decisions).

Board. Referred to collectively as the Board of Supervisors for Pima County and the Board of Directors for the Pima County RFCD.

Built environment. The GIS shapefile representing pre-permit land uses in Pima County. It was developed in 2008 by Pima Association of Governments, and updated by Pima County.

Certificate of Coverage Program. The program through which the County will grant Section 10 permit coverage to any property owner, at their discretion. This program affords the developer of a home, subdivision, commercial, or industrial project an opportunity to comply with the ESA for activities that are permitted by the County. Participation in the program is voluntary and in the sole discretion of the private developer.

Changed circumstances. “Changes in circumstances affecting a species or geographic area covered by an HCP that can reasonably be anticipated by Plan developers and the USFWS and that can be planned for (e.g., the listing of a new species, or a fire or other natural catastrophic event in areas prone to such events).” (50 CFR §17.3).

County. When referring to the applicants, Pima County and Pima County RFCD. When referring to mitigation lands, lands managed by either of the two applicants.

Covered Species. Species covered under Pima County’s Section 10 permit.

Fee simple. A term of property law where the owner has title (i.e., ownership) to the land.

Implementing Agreement. Specifies all terms and conditions of activities under the HCP. By signing the Implementing Agreement, USFWS explicitly acknowledges approval of the plan and declares that it meets the requirements of an HCP to allow issuance of appropriate permits for target or other named species, should those species become listed.

Incidental take. Take that results from, but is not the purpose of, carrying out an otherwise lawful activity. Take can be both lethal and non-lethal.

Incidental take permit (also called Section 10 permit). A permit issued under Section 10(a)(1)(B) of the Endangered Species Act to a non-Federal party undertaking an otherwise lawful project that might result in the incidental take of an endangered or threatened species. Application for an incidental take permit is subject to certain requirements, including preparation by the permit applicant of a conservation plan, generally known as an HCP.

Maeveen Marie Behan Conservation Lands System (CLS). The biological reserve system design adopted as the Regional Environmental Element of Pima County's 2001 Comprehensive Plan Update, and any subsequent revisions. The CLS provides the principal basis for the selection of lands for mitigation under the permit.

Mitigation Lands. Those lands, leases, or rights held by Pima County and committed as compensation for impacts to habitat of Covered Species stemming from Covered Activities under Pima County's Section 10 permit. Mitigation lands are either owned in fee simple, leased, or held as a partial property right (e.g. conservation easement or other legally enforceable property right).

Mitigation lands, County-controlled. All mitigation lands for which Pima County has a property interest (e.g., fee simple ownership, conservation easement, or grazing lease). Excludes mitigation lands derived from the Certificate of Coverage Program.

Mitigation lands, County-owned. All lands that are owned by Pima County in fee simple and used as compensation for impacts under the terms of Pima County's Section 10 permit.

Pima County. When referring to the proposed permit holder, the term includes Pima County RFCD, a separate taxing authority that is governed by the same elected officials as Pima County.

Preserve Network (Pima County). Land owned and managed for open space preservation, considered in the aggregate. Includes all County-controlled mitigation lands, as well as other Pima County preserves (e.g., Tucson Mountain Park) for which no habitat mitigation credit is being sought.

Priority Conservation Area. Those areas identified by species experts where conservation is necessary for the Covered Species' long-term survival.

Regional Flood Control District (RFCD). The Pima County RFCD is a separate legal entity from Pima County, and one of the two applicants in the MSCP.

Sonoran Desert Conservation Plan (SDCP). Overarching conservation plan for Pima County. The Pima County MSCP is one element of the plan, which includes cultural resource goals, as well as biological goals.

Unforeseen circumstances: "Changes in circumstances affecting a species or geographic area covered by an HCP that could not reasonably have been anticipated by plan developers and the USFWS at the time of the HCP's negotiation and development, and that result in a substantial and adverse change in the status of the Covered Species." (50 CFR §17.3).

14.2 Acronyms

ADWR	Arizona Department of Water Resources
AZGFD	Arizona Game and Fish Department
ALWT	Arizona Land and Water Trust
AZCC	Arizona Conservation Corps
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CLS	Maeveen Marie Behan Conservation Lands System
Corps	U.S. Army Corps of Engineers
GIS	Geographical Information System
HCP	Habitat Conservation Plan
MSCP	Multi-species Conservation Plan
NRPR	Natural Resources, Parks and Recreation Department (Pima County)
OSC	Office of Sustainability and Conservation (Pima County)
PCEMP	Pima County Ecological Monitoring Program
RFCD	Pima County Regional Flood Control District
USFWS	United States Fish and Wildlife Service

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2018 MSCP Annual Report – List of Appendices

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- Appendix 2. Bingham Management Plan (70p)
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- Appendix 4. Pima County Capital Improvement Projects (CIP) Completed in 2018 (2p)
- Appendix 5. Gila topminnow as vector control: Green Pool list (1p)
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- Appendix 13. Draft Pima Pineapple Cactus Monitoring Protocol – Health Condition Assessment Rubric (5p)
- Appendix 14. Location and Status of Unsupplemented, Foresummer Surface Water on Pima County Conservation Lands, 2011-2017 - Final Report (36p)
- Appendix 15. RFCD Shallow Groundwater Monitoring Protocol (14p)
- Appendix 16. Raising the Arizona Eryngo Report (11p)
- Appendix 17. Pima County Local Drought Impact Group - 2018 Annual Report (10p)
- Appendix 18. MSCP potential mitigation land acquisitions and releases during 2018 (3p)

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 1

**List of 404 permits issued in 2017 for
Pima County's Section 10 permit compliance**

**404 Permits Issued by U. S. Army Corps of Engineers contingent on
Pima County's Section 10 permit for ESA compliance**

Corps File Number	Type of Permit Issued	Landowner	Agent	Lat/long	Location by parcel or addresss	MSCP coverage authorized? (y/n)	Grading executed? (y/n)
SPL201700233	RGP-81	Pima County	RFCD	32.36963/- 111.13768	T:12S; R:12E; S8	yes	2017

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 2

Bingham Cienega Management Plan



PIMA COUNTY

BINGHAM MANAGEMENT PLAN

January 2019



Recommended Citation:

Pima County. 2019. Bingham Management Plan. Report submitted to the U.S. Fish and Wildlife Service as part of partial fulfillment of obligations under Incidental Take Permit TE-84356A-0.

Cover photo: Bingham Cienega (foreground) and the Galiuro Mountains (background), February 2011. Photo by Brian Powell



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Abstract

Bingham Cienega, located along the San Pedro River, has been selected for the first management plan submitted to the U. S. Fish and Wildlife Service under the Multi-Species Conservation Plan. The site was chosen because of the property's small size, remoteness, and the need for updating an outdated management plan to reflect more recent acquisitions and changed ecological conditions. The new plan addresses the following Conservation Targets:

- Wildlife habitat connectivity;
- Mesquite bosque and other distinct plant communities;
- Native aquatic species;
- Shallow groundwater and surface water discharge in the Bingham Planning Area;
- Tributary streamflow and recharge from outside the Bingham Planning Area;
- Cultural resources; and
- Visual resources.

Though the Multi-Species Conservation Plan obligates that certain topics be addressed, the plan's scope was expanded to address broader goals and topics. Additional topics—selected by the planning team—include ranch resources, fire management, public use, caretaking and visual resources, all of which tie the Bingham Planning Area into the larger landscape setting of the San Pedro Valley and adjacent ranches.

Many changes in the condition of resources in the Bingham Cienega Natural Preserve have occurred over the last 20 years. As a result, many of the objectives in this new management plan reflect the need to better monitor and study conditions and to choose actions that have the most potential to stabilize or enhance the conditions of the Conservation Targets (Targets). This management plan emphasizes maintaining and monitoring system processes rather than artificially restoring past conditions.

The management for each resource or topic is separated into “recommended actions” that are within the Pima County's purview, and “management opportunities” that involve collaboration with others, usually for a common purpose that extends beyond the Bingham Planning Area. In particular, Pima County intends to use the final list of actions and opportunities identified in this plan to guide future management of tributary watersheds that lie within Pima County management. Existing Restrictive Covenants and a Conservation Easement also guide future management within the Bingham Planning Area, and copies of these are attached as appendices.

Actual selection of actions will depend on funding, collaborative opportunities, and staffing relative to other lands in the Multi-Species Conservation Plan portfolio. Pima County anticipates continued dialogue with U. S. Fish and Wildlife Service and others on management and any biological enhancements.

1 Introduction

1.1 Geographic Location

The Bingham Cienega Planning Area (Planning Area) is located in the Lower San Pedro River valley of southern Arizona, in northeastern Pima County (Figures 1.1, 1.2). This part of the San Pedro river basin represents the eastern edge of the Sonoran Desert and western edge of the Chihuahuan Desert where a short distance separates the Santa Catalina-Rincon mountains complex to the west and the Galiuro Mountains to the east. It is a place of confluence and diversity.

The land surrounding the Planning Area is owned and managed by a tapestry of federal, state, Pima County, private landowners and corporations (Figure 1.1). The highest elevations in Santa Catalina, Rincon, and Galiuro mountains are predominantly managed by the U. S. Forest Service and National Park Service, and include forested patches of oak, juniper and conifers. The mountains have extensive alluvial aprons of coarse gravels mantled with semi-desert grassland and desert scrub. This apron, or bajada, is majority owned by the state of Arizona. Pima County holds a number of grazing leases on state land near to the Planning Area. These grazing leases are associated with the A7, Six-Bar, M Diamond, and Tesoro Nueve ranches. Private ownership in the vicinity of the Planning Area is relatively limited, and occurs primarily along the San Pedro River bottomlands. Here, the Bayless and Berkelew Corporation is a significant land owner. The U. S. Bureau of Land Management (BLM) also manages a portion of the watershed.

Within the Planning Area itself, most of the land is part of the Bingham Cienega Natural Preserve (Preserve) owned by the Pima County Regional Flood Control District (District). Smaller parcels that are part of the Planning Area are near to the Bingham Cienega and are part of Pima County's M Diamond Ranch (Fig. 1.2). Importantly, the Planning Area includes a 19-acre residential inholding that is in a Life Estate owned by the Kelly Family and held in a Conservation Easement by The Nature Conservancy (TNC). Management of the residential inholding will be guided by this plan only after the Life Estate is completed.

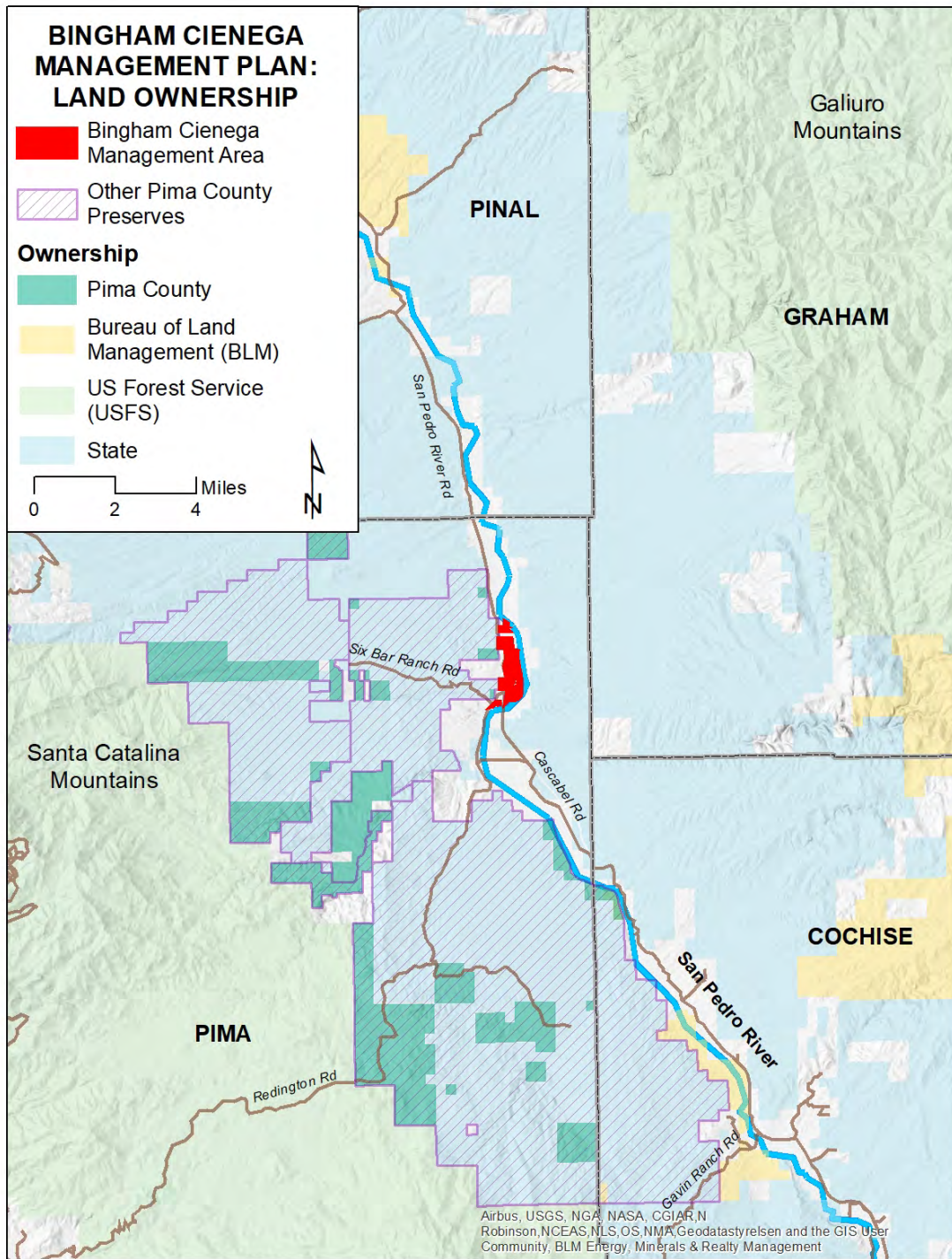


Figure 1.1. Location of the Planning Area in relation to the San Pedro River and adjacent counties.

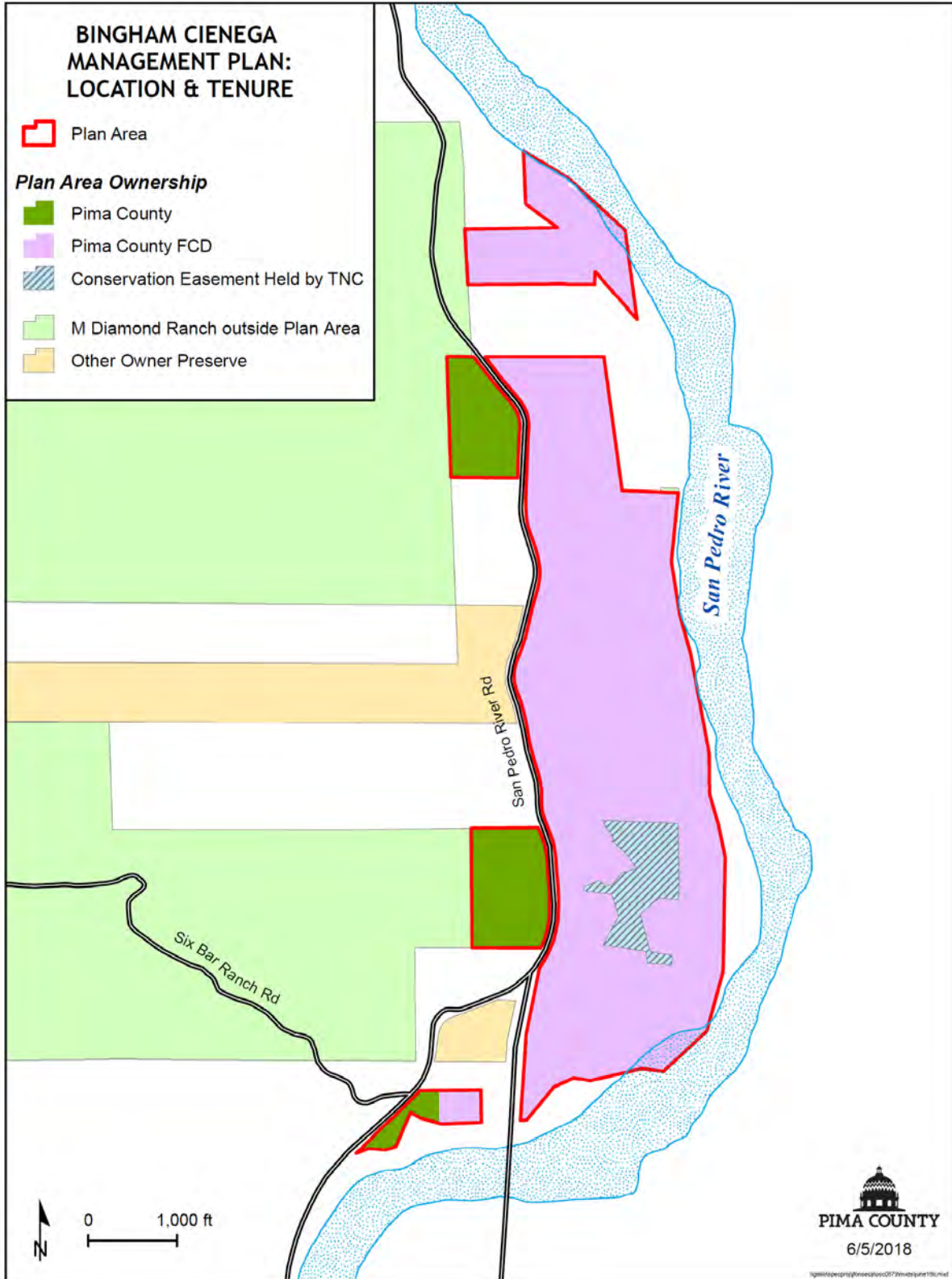


Figure 1.2. Planning Area boundaries and land ownership.

1.2 Socio-Cultural Setting and Land Use

Approximately 100 people live in the northeast portion of Pima County, principally along the San Pedro River Road (unpublished analysis on 2010 census data by Carolyn Leung, Pima Association of Governments for this plan). Residents rely primarily on long-distance travel to obtain food, medical care and other necessities. Several volunteer fire departments in the valley are no longer in operation, and there are fewer and fewer families engaged in agriculture. During the 1980s and 1990s, parcels were being split into smaller lots and sold for residential use as the older generations passed on (The Nature Conservancy 2000). One effect of this lot splitting was to fragment ownership and increase the number of absentee land owners. The Sonoran Desert Conservation Plan (SDCP) has, to some degree, mitigated this trend in the watershed surrounding the Planning Area by providing justification and funds to acquire and manage cattle ranches in cooperation with small-scale ranchers (Pima County 2000a, b).

Land use in the areas surrounding Bingham Cienega are primarily cattle ranching and alfalfa farming. Because most of the lands upon which cattle ranching occurs have naturally low productivity, ranching depends on irrigation of pastures and croplands to supplement feed. In the last several decades, diversion of the San Pedro River upstream of Bingham Cienega for irrigation has ceased due to the scarcity of any base flows in the river itself near Redington, Arizona. Agriculture now depends solely on high-lift turbine pumps and increasingly expensive electricity. Pima County and the Bayless and Berkalew Ranch are the main water users near the Planning Area (Table 1).

Recreation in the San Pedro basin includes hunting, hiking, camping, mountain biking and all-terrain vehicle use. The principal recreational access points are along the Redington and San Pedro River roads. The San Pedro Road, in particular, is a critical feature for residents. Erosion and flooding (principally along tributaries to the San Pedro River) can temporarily eliminate road access for residents. Changes in the drainage along San Pedro River Road in Pima County, which is maintained by Cochise County, have the potential to adversely affect the Planning Area. At one time, the Arizona Department of Transportation (ADOT) considered an Interstate 10 bypass highway along the San Pedro River, but the plans were dropped and the associated right-of-way for the highway was released.

No mining is known to have historically occurred in the Planning Area, but nearby Buehman Canyon and the Oracle Ridge areas in the Santa Catalina Mountains have been the focus of recent exploration activities for potential mines. The Oracle Ridge Mine is now in receivership and the Korn Kob claim in Buehman Canyon is currently inactive. However, mining claims to these and other areas are still held by private entities.

The Arizona State Land Department (ASLD) leases land for grazing, various pipelines, roads, utilities, minerals and other purposes, and represents another source of uncertainty in terms of future land use because of the agency's mission to maximize revenue for public trusts. Most recently, the SunZia power line has been approved by federal regulators; that line crosses many areas of State land. No date for construction has been established.

In terms of social networks, the Redington Natural Resource Conservation District (NRCD) seems to be the principal group in the area (Table 1). There is also a nascent watershed

group for the Lower San Pedro River. Pima County maintains ties with various land owners and non-governmental organizations operating in the valley.

Table 1.1. Key organizations operating within and/or near to the Planning Area, 2018.

Name	Effect on conservation activities
Pima County	Manages County-owned ranches, and recreation on County parks
	Monitors conditions on County-managed conservation properties
Pima County Regional Flood Control District	Manages floodplain uses on private and state trust lands
	Operates the Floodprone Land Acquisition Program
	Oversees land they own, has a riparian restoration program
	Operates flood warning system including rain gages
Pima County Sheriff's Department	Law enforcement response
Arizona State Land Department	Administers leases on State Trust Land adjoining Bingham
Arizona Department of Forestry	Potential partner in fire suppression and post-fire restoration
U. S. Forest Service	Administers activities on USFS land in the watershed
	Potential partner in preserving land connectivity and fire management
U. S. Bureau of Land Management	Oversees County use of BLM land south of Bingham Cienega
Arizona Game and Fish Department	Manages hunting and ATV use
	Law enforcement response
	Administers hunting licenses and fish stocking
	Oversees a program to monitor and restore native wildlife
	Administers Heritage funds for inventory and management
The Nature Conservancy	Nearby conservation land owner
	Holds and monitors Conservation Easements at Bingham and on nearby private lands
Redington Natural Resources Conservation District	Can receive and implement grants for conservation projects
	Can solicit community input and disseminate information to land owners
Archaeology Southwest	Nearby conservation land owner
Bayless and Berkalew Ranch	Neighboring land owner with farming operation along San Pedro River
	Potential help with feral pig control
	Current cattle ranching operator at the County's A7 Ranch
Kelly-Bingham family	Neighboring set of land owners; Jack and Lois hold a Life Estate in the Planning Area
Goff family	Current operator for Pima County's Bar V Ranch (upstream watershed)
Cochise County	Maintains San Pedro Road via contract to Pima County
Sulfur Springs Valley Electric Cooperative	Utility company that maintains power line easement at Bingham
Bellota Preservation Corporation	Nearby conservation-oriented landowner. All Bellota parcels are under under a Conservation Easement
Lower San Pedro Collaborative	Watershed planning group made up of conservation professionals, interested citizens, and some key land owners

Animal Plant Health Inspection Service (APHIS)	Potential partner in managing feral pigs
--	--

1.3 History of Pima County Acquisitions in the Planning Area

In 1978, the Arizona Natural Heritage Program identified Bingham Cienega as one of Arizona’s rarest natural features due to its spring-fed wetlands. The 1986 Arizona Wetlands Priority Plan (sponsored by Arizona State Parks Board and Arizona Game and Fish Department [AZGFD]) identified the property’s wetland and riparian forest as reason to target the site for acquisition by a federal, state, or local government. As a result, the Pima County Flood Control District (District) acquired the Bingham property as part of its Floodprone Land Acquisition Program, marking the second time in the District’s history that the program was used to protect a natural floodplain area from development¹.

As part of the Bingham acquisition, the District signed and funded a 25-year management agreement with TNC to “protect, preserve, and enhance its riparian and aquatic habitat and other natural values.” The District further agreed to refrain from conducting or permitting any use of the property that would adversely affect its ecological, scenic, flood mitigation, or recreational values.

The acquisition included many acres of farm fields from which natural vegetation had been cleared. After the acquisition, the wetlands reclaimed some of the former farmland, thereby considerably expanding the extent of wetlands. A restoration project funded by the Arizona Water Protection Fund helped to establish native vegetation in former farm fields that lay outside the wetland, and all the while TNC worked diligently to inventory and monitor site conditions, maintain fences, manage fire risk, and take other measures necessary to protect native plants and animals and ecosystem processes.

In 2000, Pima County’s SDCP identified the San Pedro River Valley for long-term conservation via a “working landscape” or ranch conservation approach (Pima County 2000b). In 2004, Pima County voters authorized funding for purchasing open space from willing sellers. In the San Pedro Valley, the first acquisition opportunity arose with the City of Tucson, which was looking to transfer ownership of the A7 Ranch (located upstream and adjacent to the Planning Area) to Pima County. Soon after this acquisition, Pima County purchased the Six Bar Ranch, then later the M Diamond Ranch. Portions of the Planning Area, which includes parts of the M Diamond Ranch were conveyed to both Pima County and the District.

1.3.1 Bingham Acquisition Timeline

1988. Jack and Lois Kelly approached TNC of Arizona about a possible sale of approximately 300 acres at Bingham Cienega, which surrounded the headquarters of their M Diamond Ranch.

¹ Floods and erosion from the San Pedro River are a natural part of this landscape, and one purpose of the acquisition was to allow those processes to continue unhindered.

1989. TNC and the District agreed to an arrangement whereby the District acquired Bingham Cienega and TNC would hold a Conservation Easement to the 19-acre inholding that was retained in Kelly ownership. A Conservation Easement, which is held by TNC, is placed on the inholding. Over the next 25 years, the District paid TNC to manage what is now known as the Bingham Cienega Natural Preserve. During this time, TNC—in cooperation with the District—maintained fences, carried out research and monitoring, and oversaw restoration of former farm fields (The Nature Conservancy 2001).

2012. The Kellys sold the M Diamond Ranch, including the 19-acre inholding, to the Oracle Ridge Mining Corporation. Through an agreement with Oracle Ridge, Pima County and the District acquired the M Diamond Ranch. Pima County Natural Resources, Parks and Recreation Department (NRPR) assumed the associated grazing leases while the District took possession of the private, floodprone portions of the M Diamond Ranch. In addition, a Life Estate was established to allow the Kellys to maintain residential occupancy and full management of the inholding.

2014. The management agreement between the District and TNC ends and the District transferred site caretaking responsibilities to NRPR. All site management, monitoring, and reporting activities that were carried out by TNC were retained by NRPR and new fire preparedness activities were initiated. TNC continues Conservation Easement monitoring of the 19-acre inholding Life Estate.

2016. Pima County and the District obtained a Section 10 (a)(1)(b) (herein Section 10) permit for incidental take of species under the Endangered Species Act (Pima County 2016). In a related action, most of the Planning Area was encumbered with restrictive covenants to ensure the mitigation values of the properties are not impaired (Appendix A).

2017. A portion of the Planning Area was allocated as mitigation under the Section 10 permit, triggering a requirement for a management plan to be provided by March 1, 2019 to U. S. Fish and Wildlife Service (USFWS).

2018. The District acquired a small parcel of the San Pedro River floodplain from Durango Land and Cattle. This parcel was added to the Planning Area.

1.4 Significance of the Planning Area

The Planning Area serves many purposes and contributes many different outcomes:

- The area's natural state helps conserve natural floodplain function and sediment storage along the San Pedro River and tributaries. Some of the tributaries are already entrenched all the way to the San Pedro River, but several distributary flow systems persist on the Holocene alluvial terraces, thereby providing long-term sediment storage and attenuation of flood flows.
- Natural wetlands, which are present onsite, are regionally scarce. As early as 1978, the state's Natural Heritage Program identified Bingham Cienega for protection, as did the state's Wetland Priority Plan and state Natural Areas Study. Even though the current condition of these wetlands is poor due to a rapidly declining water table, the natural condition of the site would most likely allow the wetlands to return if and/or when the water table rises to its previous position.

- The area provides extensive forests of mesquite woodland (bosque) in a portion of the San Pedro River Valley where much removal of mesquite has occurred because of clearing for agriculture. As such, the remaining mesquite forest in the Planning Area provides an important patch of this regionally rare vegetation type. The conservation of mesquite at Bingham is complemented by TNC's acquisition of the adjacent Rhodes/Furrow property.
- The acquisition conserves natural and restored patches of sacaton-mesquite savanna that were historically much more common in this part of the San Pedro River Valley.
- The site provides landscape-level wildlife connectivity along the San Pedro River and between the Catalina-Rincon mountain complex and the Galiuro Mountains. The value of this wildlife connectivity is recognized at the state level.
- For the MSCP, the Planning Area conserves Important Riparian Areas that include Priority Conservation Areas for many covered species, including the yellow-billed cuckoo, and others. Conservation activities here serve as mitigation to offset impacts to Pima County projects and private developments that occur elsewhere in Pima County's Section 10 permit area.
- The acquisition has stabilized the living situation for one of the area's oldest ranch families, and has contributed to a sense of tradition and place by preventing subdivision and lotsplits. The Life Estate has allowed the Kelly family to continue to inhabit this historic homestead and engage in activities such as maintaining crop seed varieties derived from their forebears. Their sale of the M Diamond Ranch to Pima County has helped to ensure future succession to a small-scale rancher.
- The property is located within a zone of high archaeological sensitivity as defined in the SDCP (Pima County 2000c). Archaeologists have identified many archaeological and historic sites in the Lower San Pedro River Valley. The acquisition provides the opportunity to preserve archaeological and historic sites.
- The infrastructure investments made by the District have contributed to fire preparedness in a remote rural area that has experienced loss of volunteer firefighting capabilities.

1.5 Need for Revision of the 1992 Bingham Management Plan

Collazo (1992) prepared the only comprehensive management plan for the Preserve. A new, more up-to-date management plan is needed because:

1. TNC's 25-year management agreement with the District has ended;
2. Many management objectives were addressed during TNC's tenure including the inventory of biological resources, fencing, monitoring, active vegetation restoration efforts, fish introduction, invasive species management and initiation of fire preparedness;
3. Conditions have changed from an expanding to significantly reduced cienega;
4. Additional nearby lands have been acquired by Pima County and the District, which are being addressed in the new planning effort; and
5. Pima County and the District now hold a permit under the Endangered Species Act, which requires certain planning, management and monitoring activities take place.

Because of these conditions and needs, the new planning effort—outlined in this document—will result in a management plan that is appropriate for the new land ownership and conditions within the Planning Area as well as management capacities for Pima County departments.

2 Planning Process and Framework

2.1 MSCP Obligation

The Planning Area was selected to be the first MSCP-compliant management plan because of the property's size, remoteness, and long history of being managed for natural resource protection and research. The Planning Area is primarily located in the Important Riparian Area of the Maeveen Marie Behan Conservation Lands System (Figure 2.1). There are also two tracts of land within the Biological Core that have Sonoran desert scrub located on old terraces west of the San Pedro River Road.

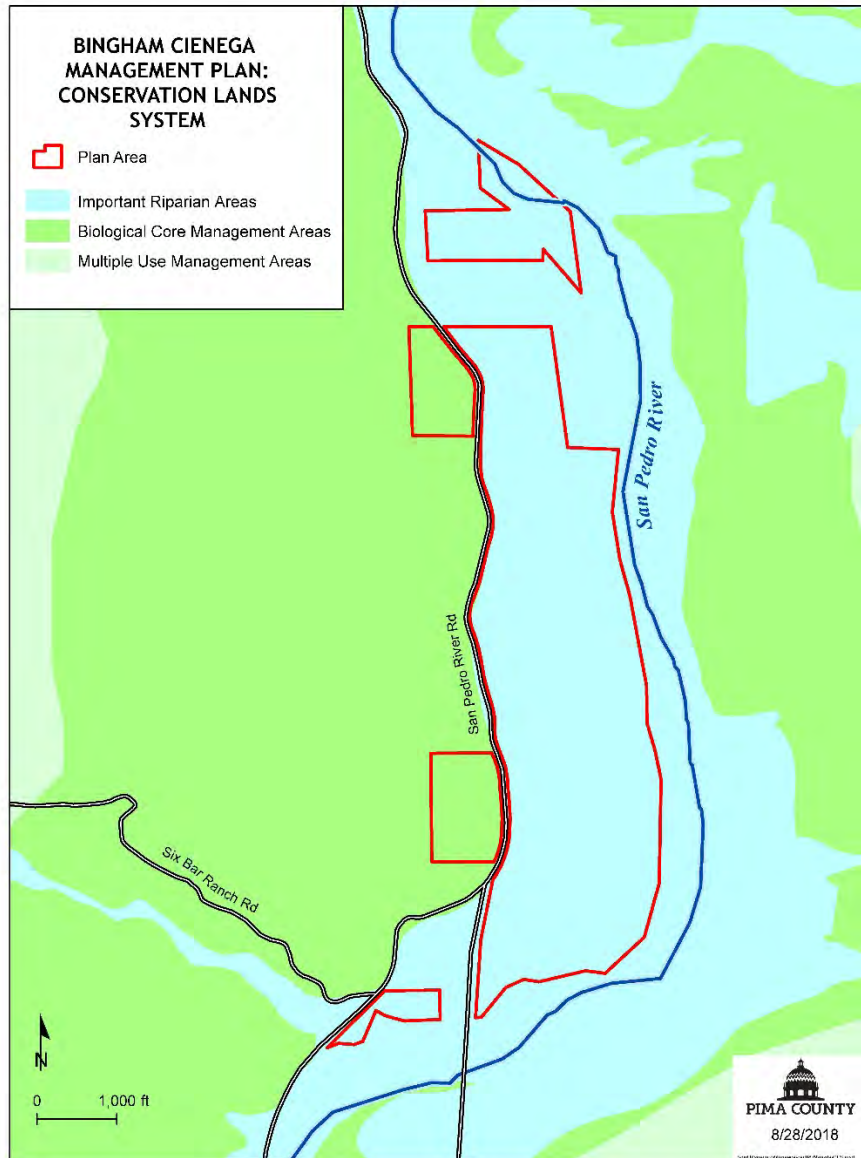


Figure 2.1

The Planning Area is located in the Important Riparian Area of the Maeveen Marie Behan Conservation Lands System. The Planning Area is primarily located in the Important Riparian Area of the Maeveen Marie Behan Conservation Lands System (Figure 2.1). There are also two tracts of land within the Biological Core that have Sonoran desert scrub located on old terraces west of the San Pedro River Road.

Planning Area.

located to MSCP compliance because of its size and location. These areas were chosen for the Planning Area.

adjacent parcels are likely to be needed to offset MSCP mitigation obligations through 2019².

Table 2.1 Parcels in the Planning Area

Parcel tax code	Owner
205-20-004D	Pima County Regional Flood Control District
205-17-002A	Pima County Regional Flood Control District
205-17-005L	Pima County Regional Flood Control District
205-17-005P	Pima County
205-17-005Q	Pima County
205-17-010H	Pima County
205-17-010J	Pima County Regional Flood Control District
205-17-010K	Pima County Regional Flood Control District
205-17-0120	Pima County
205-21-002D	Pima County Regional Flood Control District
205-21-002E	Pima County Regional Flood Control District
205-21-002F	Pima County Regional Flood Control District
205-22-002A	Jack and Lois Kelly Life Estate then to Pima County Regional Flood Control District

In 2017, Pima County developed a management plan framework to assure that new management plans for MSCP mitigation properties meet the mitigation requirements of the Section 10 permit. Land management actions under the Section 10 permit will (Pima County 2016; Chapter 5):

- “Work toward the long-term viability and sustainability of native ecosystem structure and function and natural processes;
- Protect biological resources from threats and other activities, while accommodating compatible uses;
- Enhance and restore Targets in appropriate locations to improve habitat for Covered Species and other species of interest;
- Respond to monitoring information in a timely manner and use adaptive management, where and when such an approach is warranted; and
- Directly address the management activities related to the maintenance of MSCP resources including, but not limited to, avoidance and minimization efforts to ensure protection, species and habitat needs, emerging threats, invasive species removal needs, ordinance enforcement activities, and anticipated future resource needs.”

² The amount of land needed for mitigation depends on a number of factors, most importantly the location and extent of impacts. Pima County will launch new management planning efforts elsewhere by 2019 to address future mitigation obligations.

Pima County staff developed an outline for the management plan, which included timeframes and a planning team (Team) comprised of staff members from the District, Office of Sustainability and Conservation (OSC), and NRPR. The directors of each department have since provided oversight of the planning effort.

2.2 Bingham Planning Framework

While the MSCP provides guidance for what must be addressed in management plans, it does not prescribe the approach to be used. In fact, it recognizes that planning can utilize a variety of mechanisms. For this plan, Pima County has employed aspects of the Conservation Action Planning framework developed TNC (The Nature Conservancy 2007). This framework was developed to help land managers conserve biological resources by providing guidance manuals and templates that have been used in similar planning exercises by the TNC for the San Pedro River basin and elsewhere.

2.2.1 Selection of Targets

A critical step in a land conservation program is to identify resources of interest that can be used to focus land management decisions. The Team evaluated and identified a host of important natural and cultural resources, known as Targets that occur—or have a high likelihood of occurring—within the Planning Area and surrounding lands. Targets can range from species to habitat and landscape-level elements. According to TNC (2007), targets should:

- Represent biodiversity at the site.
- Reflect existing conservation goals.
- Be viable or at least feasibly restorable.
- Be highly threatened.

Targets for the Middle San Pedro River were first identified by Harris (2000) and later refined based on conversations with Mr. Bob Rogers (TNC program manager for the San Pedro River) and internal Pima County discussions. The Team chose the following Targets:

- Wildlife habitat connectivity;
- Mesquite bosque and other distinct plant communities;
- Native aquatic species;
- Shallow groundwater and surface water discharge in the Planning Area;
- Tributary streamflow and recharge from outside the Planning Area; and
- Cultural resources.

Though the MSCP was the catalyst for the management plan, the plan's scope was expanded beyond natural to cultural resources to address SDCP goals related to ranch and cultural resources and to create a more holistic management framework. Additional topics selected for the plan by the team include fire management, public use, caretaking and visual resources, all of which tie the Planning Area into the larger landscape setting.

The targets chosen for this plan include a wide range of resources that vary with regard to the spatial scale of the threats and stressors and the potential management actions. Scale is an important consideration because it allows for an honest assessment of the range of

realistic actions (The Nature Conservancy, 2007). For example, shallow groundwater levels in the Planning Area have dropped precipitously in the last 15 years (see Background Report), but most of the key drivers of this phenomenon (drought, climate change, and groundwater pumping) are beyond Pima County's capacity to influence.

2.2.2 Stressors, Threats and Situation Analyses

Threats are human-caused disturbances to Targets, while stressors are attributes of a conservation target that are impaired directly or indirectly by human activities (Salafsky et al. 2008). A stress is not a threat in and of itself, but rather a degraded condition or "symptom" of the target that results from a direct threat. The Team compiled a list of 97 potential threats for the Planning Area.

The significant changes in the extent and condition of Targets in the Planning Area over the past two decades led to robust discussions of the relationship of threats and stressors to the identified Targets. The Team inventoried resources and infrastructure and reviewed existing information to better understand the conditions and relationships between stressors and Targets, and to develop potential recommendations. The Team is documenting the inventories and review in a separate background report.

One of the tools that we found to be useful to depict the relationship between stressors and threats is the situation analysis diagram. TNC staff shared generic situation analysis diagrams relative to Targets and stressors that we have in common. We then developed our own situation analysis diagrams to summarize the relationship between threats and stressors and Targets in the Planning Area (Figs. 2.1-2.5). Many changes to the condition of resources in the Preserve over the last 20 years of the District's tenure inform the fact that many stressors acting on the targets are beyond Pima County's ability to influence. As a result, many of the objectives in this plan reflect the need to better monitor and study conditions and chose management actions that are have the most influence to enhance the condition and persistence of the Targets.

Drought illustrates a phenomenon that is beyond the scope of Pima County’s influence and affects resources within the Planning Area. The current drought has gone relatively unimpeded since the late 1990s and has led to the extreme dieback of mesquite bosque and wetland forest. As a result, the Huachuca water umbel (*Lilaeopsis schaffneriana* spp. *recurva*) has not been observed at Bingham since 2001 and spring flow ceased in 2002. The drying of the open water was followed by the death of the obligate wetland woodland forest surrounding the springhead. These changes preceded Pima County’s receipt of the Section 10 permit, and drove a change in management from a focus on restoring the abandoned farm fields to managing the risk of fire.

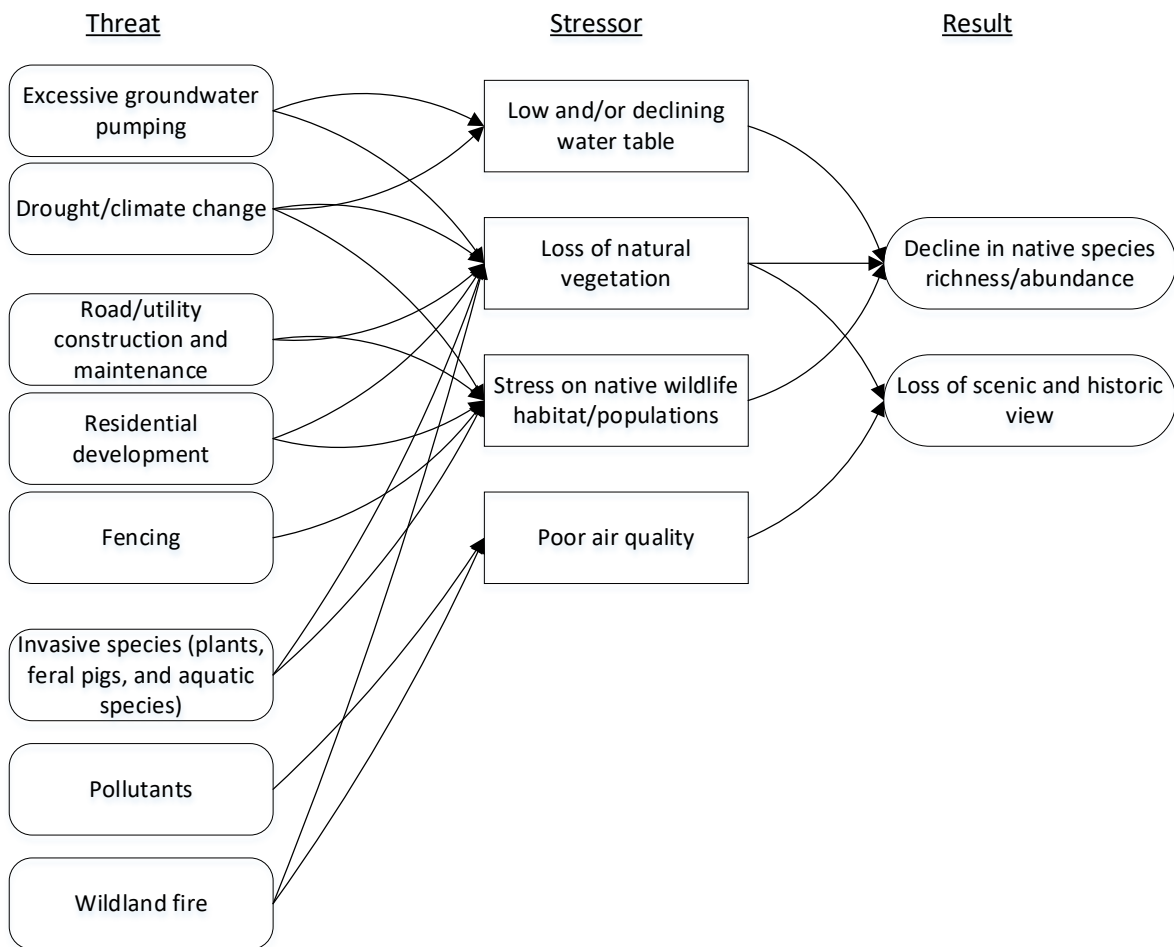


Figure 2.1. Situation analysis for landscape fragmentation and scenic resources.

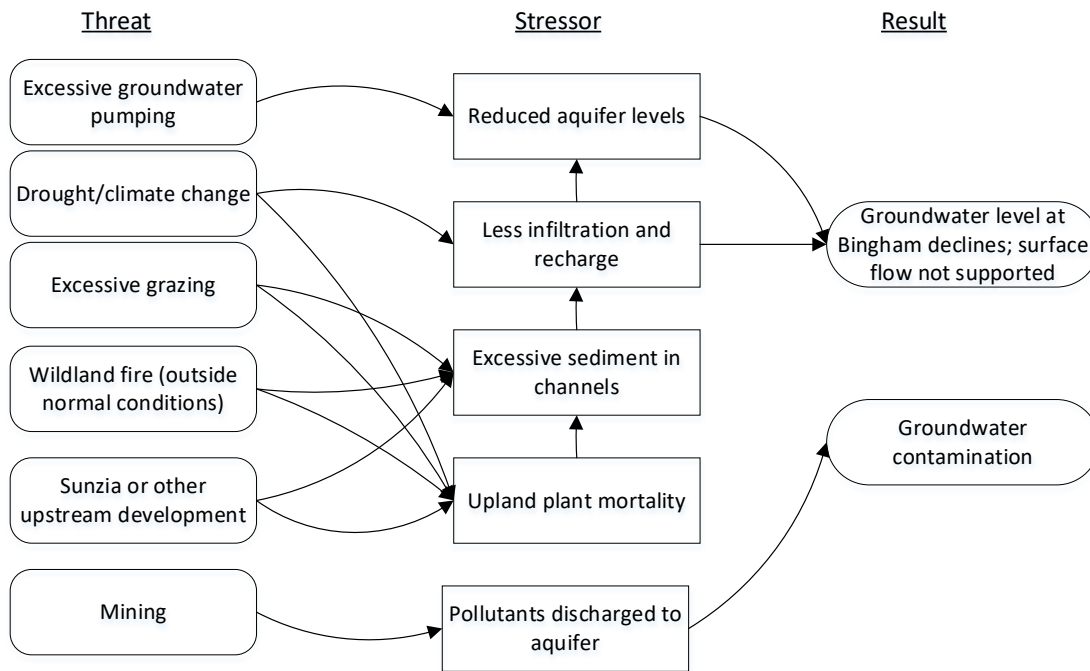


Figure 2.2. Situation analysis for tributary inflows into the Planning Area.

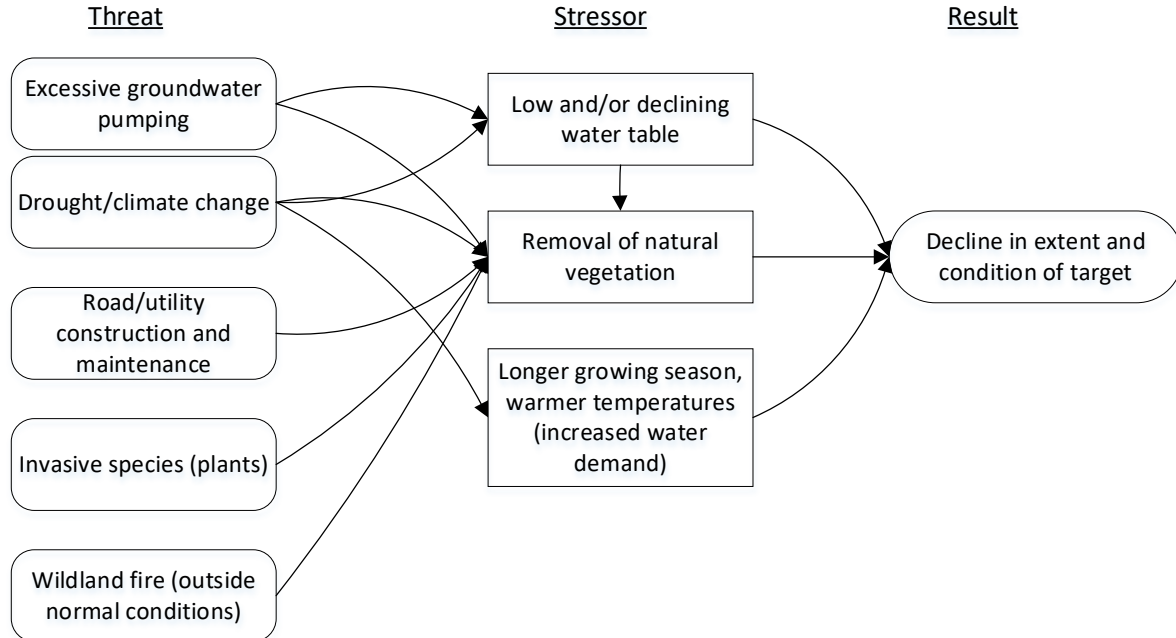


Figure 2.3. Situation analysis for mesquite bosque and wetland plant communities.

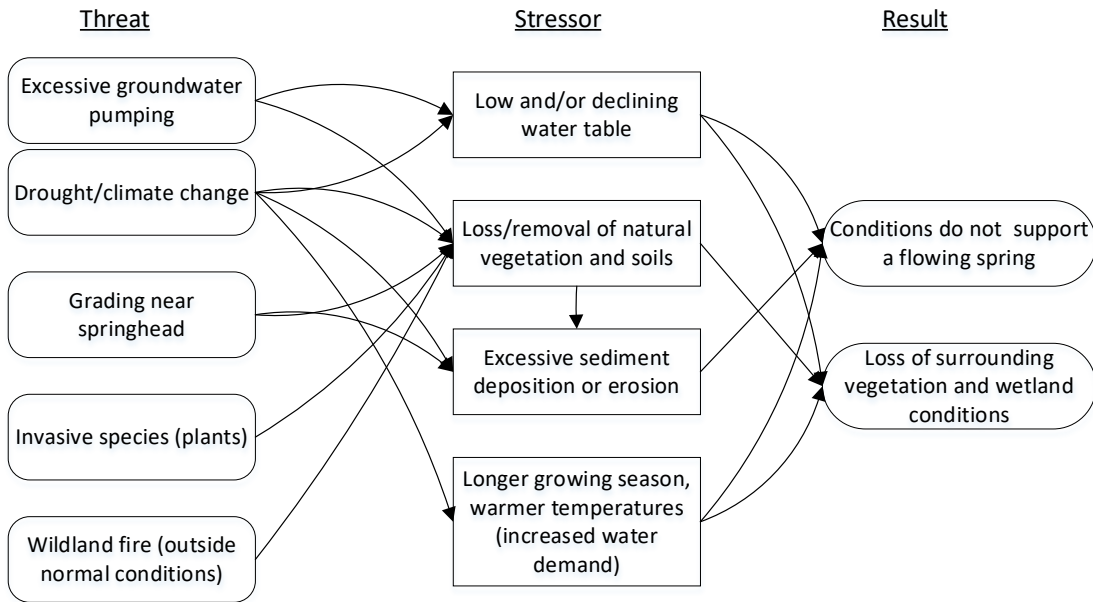


Figure 2.4. Situation analysis for the Bingham springhead.

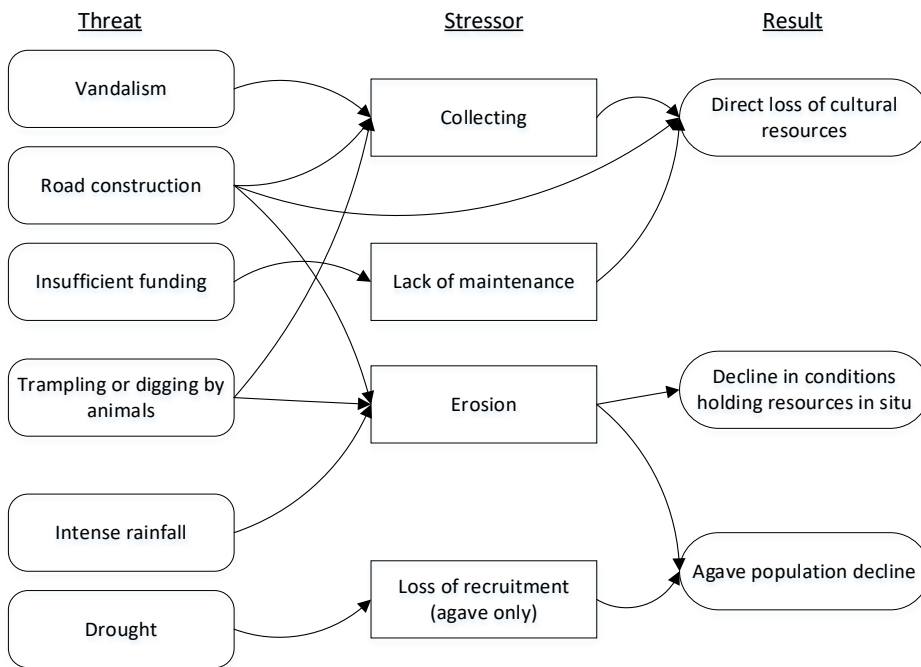


Figure 2.5. Situation analysis for cultural resources (Mormon homestead, agave and archaeological sites).

2.3 Plans for Adjacent Properties

As indicated by the situation analyses for the Targets (Figs. 2.1-2.5), most of the threats and stressors originated outside the Planning Area, but can affect its resources and management. Because of the interconnected nature of the Planning Area and adjacent and nearby lands, the team investigated plans (or land owner intentions) on some of these nearby properties and how actions there might affect the Planning Area:

- M Diamond Ranch. Because this property is managed by Pima County and contains most of the upland and tributary watersheds that debouch from the Catalina Mountains to the San Pedro River across the Planning Area, the team felt it has an important role in the Bingham Management Plan. Several of the Targets' objectives relate to management of the M Diamond. This property will eventually be grazed under a Range Management Agreement and is intended to be used for MSCP mitigation. Most of the fee lands are already restricted with covenants.
- Kelly Life Estate. When the Kellys sold their 19-acre residential inholding to the District, they retained a Life Estate on the property³. In the meantime, the Team decided to address only two general future scenarios in the management plan: (1) a tenant ranch employee related to the potential M Diamond ranch lease, or (2) a non-ranch caretaker.
- Archaeology Southwest Property. This undeveloped tract of land lies west of Bingham on terraces overlooking the San Pedro River. The owners do not have a management plan or known Conservation Easement for this property, but do not plan any development.
- Buehman Canyon Preserve. Buehman Canyon is adjacent and upstream of Bingham. The portions owned by the District are managed for long-term conservation under restrictive covenants and an instream flow water right. There is the potential for mining of the Korn Kob claim in the headwaters of Buehman Canyon. Recreation use is light.
- Furrow Bosque. Located just south of Bingham, this property will continue to be managed for conservation of the mesquite bosque by TNC.
- A7 Farm. The farm portion of A7 Ranch is south of Bingham and is owned by Pima County and leased to the Smallhouse family to be managed as a working farm in order to reduce grazing pressure on the upland areas of A7 Ranch. Groundwater is pumped to maintain irrigated pastures and water sources on the uplands. There are a number of buildings there that could be demolished or refurbished in future years. There is a Conservation Easement on the farm held by TNC. No restrictive covenants apply to these parcels.
- Bayless and Berkalew. Properties associated with this ranch and farm lie east, north and south of the Planning Area along the San Pedro River bottomlands where the

³ The parcel is owned in fee by the District, but the Kellys retain full rights to occupy and manage the property until the death of the last surviving spouse. At the time this plan was finalized, the Life Estate is currently in force.

Smallhouse family runs cattle and other livestock. Groundwater is pumped to maintain irrigated pastures on the family’s fee-owned land now that the San Pedro River no longer runs reliably at the historic ditch they operated. Though currently ranched and farmed, there is still potential for residential or other development on these properties. Future plans are unknown, but the family has a long history of agricultural enterprise.

- Miscellaneous Private Lots. There are a number of privately owned lots ranging from 10-40 acres located north and west of Bingham. Many are vacant, but some contain owner-occupied rural residences with some family livestock. Many of the properties are located in settings similar to Bingham Cienega, where fire risks are a concern. Some lots are vulnerable to flooding and erosion. During the term of this plan, the District acquired one such parcel in the San Pedro River floodplain. One upland lot just west of Bingham Cienega is on the market. Plans for these properties are unknown, but further lot splitting is expected to continue.

2.4 Foundation for Future Decision-Making

This management plan is intended to guide future decision-making in the Planning Area. The management for each resource area is separated into “recommended actions” that are within Pima County’s purview, and “management opportunities” that involve collaboration with others, usually for a common purpose that extends beyond the Planning Area. Both the actions and the opportunities are contingent on the availability of financial and staffing resources for Bingham, which must be balanced with other properties in the MSCP portfolio.

Fundamental uncertainties about the continued effects of climate change have required us to prioritize some resources over others. This 400+-acre Planning Area is part of a much larger dynamic system where the condition and/or extent of targets is influenced from forces acting at multiple scales. In fact, maintaining ecosystem structure and function—which are overarching goals of the SDCP—will not be possible without considering a broader geographic area of influence. As a result, Pima County intends to use the final list of planned actions and opportunities identified in this plan to guide future management within tributary watersheds that lie within Pima County management, particularly at M Diamond Ranch.

Most of the Planning Area was designated as Important Riparian Areas according to the County’s Conservation Land System (Pima County 2000a). The MSCP incorporated the following management principles and priorities for riparian and aquatic resources:

1. “Protect systems that are self-sustaining over those that need continual inputs;
2. Restore or enhance native riparian and aquatic ecosystems by releasing water to restore local aquifer conditions;
3. Sites which augment existing high-quality riparian areas are favored;
4. Enhance the ability of secondary effluent or reclaimed water to support aquatic life;
5. Manage riparian and aquatic ecosystems for native species; and
6. If plantings are to be used:
 - a. Revegetation is favored in areas where perpetual irrigation will not be needed;

- b. Conflicts with other public health and safety objectives (e.g., fire, flood, crime, aircraft safety, and disease) should be minimized before proceeding with these projects; and
- c. Native species appropriate to the site must be used.”

This management plan complies with these guidelines by emphasizing the maintenance and monitoring of system processes rather than artificially restoring past conditions, such as increasing groundwater pumping⁴ to sustain riparian forests.

An aquatic species management plan is another required element of the MSCP and is currently under development. The aquatic species plan prioritizes an array of covered aquatic species for establishment at sites within Pima County management. Section 4.3 of the Bingham Management Plan addresses the four covered species identified for Bingham, and coordinates those species’ opportunities for establishment with the site’s overall management. It is currently not possible to manage the pond within the Planning Area (located within the boundary of the Life Estate) for the benefit of native species until the Life Estate ends and a decision is made regarding the future caretaker. Pima County is weighing management scenarios in the plan that are consistent with obligations under the Aquatic Species Management Plan.

⁴ It is currently not possible to manage the pond within the Planning Area (located within the boundary of the life estate) for the benefit of native species, the County is weighing management scenarios in this plan that are consistent with obligations under the aquatic species management plan. That plan is another required element of the MSCP and is currently under development.

3 Rights and Constraints

There are a number of existing property rights, uses and other considerations affecting uses, which may occur within the Planning Area. This chapter describes the impact of these rights and constraints on future management opportunities.

3.1 Inholding Activities and Irrigation Agreement

Activities that take place within the 19-acre inholding (see Fig. 1.2) are private residential uses and are not under Pima County's management or guided by this plan. The inholding contains a residential structure, storage buildings, abandoned corrals, access routes and private fences and gates, a family garden, two small agricultural fields, an orchard, pond, and irrigation system. The inholding irrigation system includes two wells, pumps, aboveground and underground pipe, pond, and canals. The terms of the 2012 Life Estate make the life tenants responsible for maintenance of the inholding including insurance, utilities and taxes.

In 1989, an easement was granted by Jack and Lois Kelly to allow the District the use of the irrigation system to aid in restoration and management of the Preserve⁵. The agreement stipulated conditions of use, payment of electrical charges, and how to share the cost of system repair or replacement. The District recently paid to install a water supply standpipe on the piping of the shared well for fire safety preparedness. The shared Irrigation System Operation Easement Agreement will be honored for fire response use as well. The inholding also has an easement reserved for vehicular and livestock access that is 30-foot wide across the District's property.

3.2 Utility Easements

All deeds with easement language are on file with Pima County Real Property Services and Assessor's offices. There is a known 250' wide APS utility easement crossing the center of the Planning Area. In 2011, Arizona Public Service (APS) exercised their right of access to their power line easement and subsequently cleared their utility corridor through the Preserve. Since that time, that utility corridor has been regularly maintained—with permission from APS—by Pima County to reduce fire risk on the Preserve. There are no local sewer or water services, Communications easements lie along the San Pedro River road right of way, outside of private property.

3.3 Restrictive Covenants

Pima County has employed restrictive covenants to help ensure the underlying values of lands under Pima County's ownership are not impaired by future land managers or the Pima County Board. Restrictive covenants are also used to meet requirements of the MSCP regarding legal protection of any lands allocated as mitigation under the Section 10 permit. Restrictive covenants already constrain the potential future land uses on much of the Planning Area (Fig. 3.1, Appendix A). Pima County may choose to place restrictive covenants on the recent acquisition of the Durango Land and Cattle Company parcel in the future.

⁵ For example, it was thought that the recolonization of mesquite trees in the abandoned agricultural fields might be hastened by irrigating.

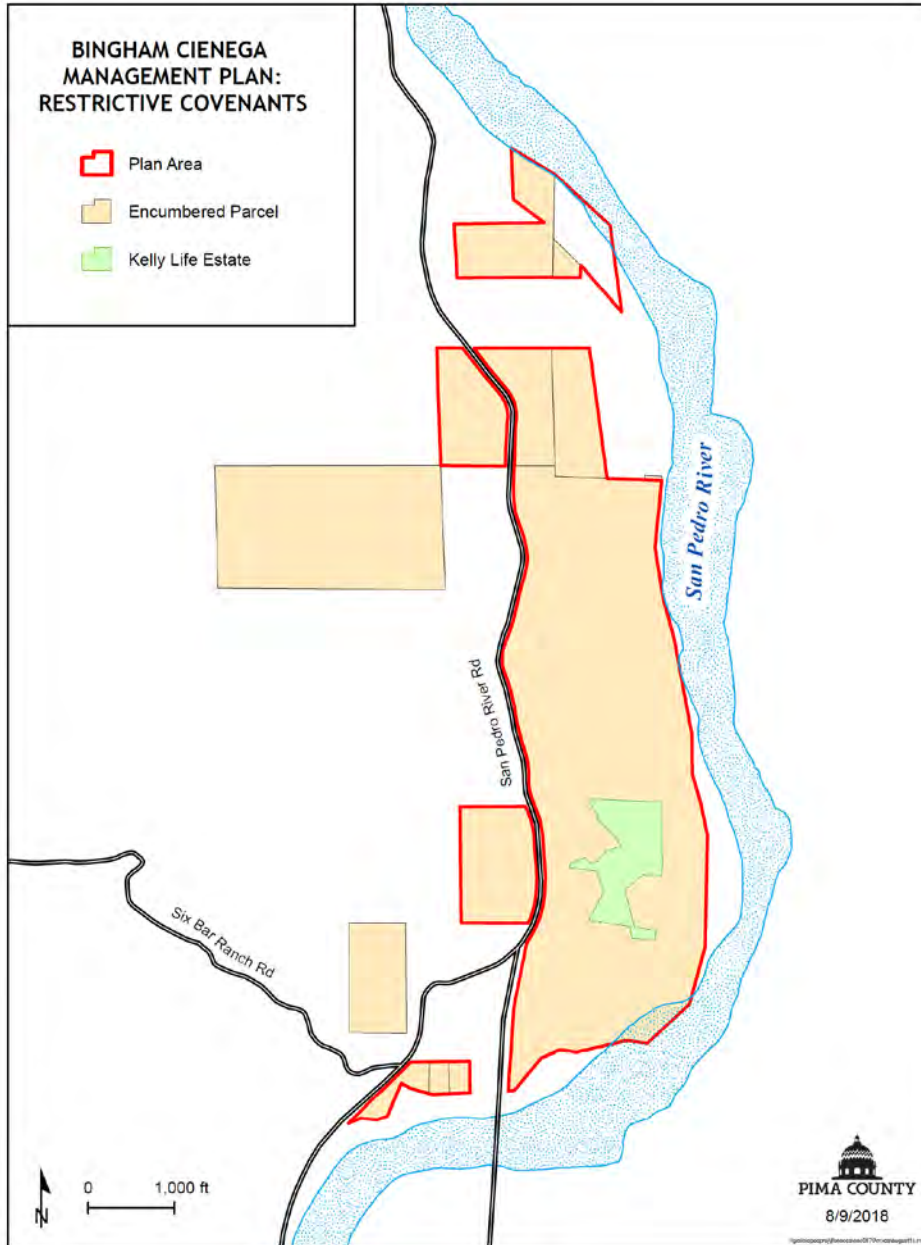


Figure 3.1. Restrictive covenants encumber most of the Planning Area, with exception of the Life Estate, where TNC holds a Conservation Easement, and a newly acquired Durango parcel at the north end.

The restrictive covenants constrain water use, removal of vegetation or minerals, subdivision and lot splitting and many other activities (Appendix A), thus providing a number of sideboards for future management of the properties. Another important function of the restrictive covenants is to require a continuing exchange of information among various parties to the agreement. Table 2 below shows the various roles of agencies in implementing the covenants. The restrictive covenants require a finding by the Pima County Board for any

health and safety exceptions not already covered in the covenants. The restrictive covenants require biennial inspection reports to Arizona Land and Water Trust.

Table 3.1. Roles and responsibilities for the restrictive covenants within the Planning Area.

Role	Name of Party	Duty	Frequency
Landowner	County (NRPR) or District	Inspect and report	Biennially, at a minimum
		Violation identification and reporting	As needed, but within 2 days of identifying
		Determine when Board action may be necessary for exceptions	As needed
Holder of Covenant	District or County	Review potential violation reports	As needed
		Review biennial inspection reports	As delivered
		Enforcing covenant	As needed
		Grant permission for release or alteration of covenants	As needed
Beneficiary	Arizona Land and Water Trust	Review biennial inspections	Biennially, at a minimum
		Decide when to enforce	At their discretion
Section 10 Regulator	USFWS	Grant permission for release or alteration of MSCP covenants	As needed
Funder	Office of Sustainability, District	Provide funding to ALWT, Oversee contract for payment	Over the next five years
Processor	Sustainability, District, NRPR, Real Property	Identify new properties to encumber, get Board approval	As needed
Recording	Real Property	Record documents with Assessor	After approval
	Office of Sustainability, IT, Department of Transportation	Update GIS layers and Pima County Government Property Rights	After approval

3.4 TNC Conservation Easement

As noted earlier, Jack and Lois Kelly retained a 19-acre inholding and conveyed a Conservation Easement (herein easement) to TNC (Appendix B), which is perpetual and restricts uses that may be incompatible with management of the adjacent Preserve. The later establishment of the Life Estate did not affect the easement.

The easement provides for residential and other uses that were deemed consistent with the conservation purposes of the adjoining land (i.e., the Preserve). Some of the rights granted to TNC as easement holder include monitoring for compliance with terms of the easement and ability to enter the property immediately, if necessary, to prevent damage to the conservation values protected by the Conservation Easement. Entry for monitoring is based on prior notice to the Kellys (Grantor) with an effort not to interfere with their use of the property. TNC currently monitors land uses in the inholding and provides an Annual Conservation Easement Report to the District.

When the Life Estate ends, the District will be the Conservation Easement Grantor. Therefore, the District will need to ensure that future occupants of the land covered under the Conservation Easement be knowledgeable of easement terms and be held accountable

through separate agreements. TNC will continue to retain the right to monitor and enforce Conservation Easement terms (Appendix B).

3.5 District and Pima County Relationships

The District owns the Preserve and NRPR manages the property including performing routine maintenance and implementation of special projects. NRPR activities at Bingham and other District properties is based on a Memorandum of Understanding (MOU) that was executed on June 23, 2016; it covered management for select portions including Bingham Cienega. Each site (or group of sites) in the MOU has assigned annual budgets, and there is an accounting of fund expenditures for land management activities. In accordance with the management agreement between the District and NRPR, field personnel at Bingham have the following responsibilities:

- **Quarterly reporting:** Photo monitoring, well monitoring (depth to water in two wells), and precipitation. NRPR staff provide reports including descriptions of any work that has been done on the preserve. Staff also report ecological data pertinent to the management of the preserve.
- **Annual (fiscal year) reporting:** Compile quarterly reporting data, update relevant maps, and summarize management activities.
- **Coordination of surveys and monitoring:** Coordinate with—and occasionally accompany—Pima County staff and outside organizations on biological, ecological and cultural resource surveys.
- **Fire prevention:** Fire lane maintenance including removing deadfall, mowing fire lanes, selective pruning, and coordinating with stakeholders on fire response preparedness.
- **Invasive species:** Monitor invasive plant and animal species and, if possible, work on solutions to eliminate or minimize impact on the preserve.
- **Fence maintenance:** Maintain interior and exterior fences.
- **Project management and supervision:** Facilitate and implement projects on the preserve, including contracting projects, overseeing and supervising crews to complete the work.
- **Security:** Provide security to the preserve and inholding residence by signage, locked gates, and keeping track of human activity on the Preserve. Assure that all visitors are familiar and compliant with entrance and egress rules.
- **Inholding residents:** Maintain a working relationship with the Kellys. Communicate with them regarding when personnel will be on the preserve and provide them with up-to-date information of any concerns such as fire hazards or trespassers on the Preserve. Allow them to voice their concerns and relay back to the District.
- **Neighboring properties communication:** Maintain an open line of communication with neighboring property owners.

3.6 Park Designation and Park Rules

The Pima County Board and the Board of Directors of the District adopted and approved Pima County and District lands including the Preserve, as Pima County parks in 2016⁶. Bingham's designation as a county park brought the property under current Pima County Parks Rules⁷. The sections of the Parks Rules that are most relevant to the Planning Area and Targets including: Vehicles must remain on designated roads; restrict collection of vegetation, wildlife, and rocks/minerals; affirm keeping all environmental settings in a natural state; and prohibit discharge of firearms, building fires, and domestic animals roaming at large. The Parks Rules are subject to change, and are currently undergoing review and revision.

3.7 M Diamond Ranch

Pima County owns fee land and holds ASLD grazing leases that compose the M Diamond, Six-Bar and A7 Ranches immediately outside of the Planning Area. Pima County staff monitor rangeland resources per Coordinated Resource Management Plans, Pima County Range Management Standards and Guidelines (Pima County 2010) and MSCP requirements. The M Diamond Ranch, specifically, is composed of 7,800 acres of ASLD leased land and 624 acres of Pima County owned fee land. Approximately 47 acres of the M Diamond Ranch fee lands are within the Planning Area.

The M Diamond is not currently operating under a Ranch Management Agreement. Former ranch owners Jack and Lois Kelly removed their livestock from the M Diamond Ranch and grazing lease in 2013 after selling the ranch to the District and Pima County. Historically, the Planning Area provided the ranch residence, headquarters with working facilities, wells, water and grazing land for the M Diamond Ranch. Because most of the M Diamond Ranch is composed of upland rangeland leased from the ASLD, the accompanying properties in the Planning Area with access to a residence, irrigation water and working corrals made raising livestock and crops much more feasible. Because water and fence infrastructure are very limited on the grazing lease, Pima County opted not to lease the ranch out immediately upon acquisition, but opted to let the land rest for a few years. That situation is likely to change in the next few years.

3.8 North San Pedro River Road

The North San Pedro River Road (also referred to as the North Cascabel Road or Redington Road on some maps), which runs from Pomerene to near San Manuel, is a dirt road that runs along the western boundary of the Planning Area. The segment of road at the Planning Area

⁶ Per joint Resolution No. 2016-65 / Resolution No. 2016-FC as allowed by A.R.S. Section 11-932. The Park Rules designation provides an additional layer of land management authority for the County and District to manage day-to-day activities on these properties. The current listing of parks and park boundaries are located on the NRPR website: www.pima.gov/nrpr.

⁷ Adopted by the Pima County Parks and Recreation Commission as the Code of Rules and Regulations for Pima County parks and recreation areas pursuant to A.R.S. 11-935(B)(2) and 11-936.

is maintained by Pima County as a dirt road within a 100-foot right-of-way. Pima County pays Cochise County approximately \$10,000 per year to maintain this unpaved road. An Intergovernmental Agreement (IGA) approved by the two Boards of Supervisors in June 2017 extended Cochise County's maintenance IGA through 2027. Pinal County paved their portion of the road in early 2017 and Cochise has steadily made upgrades to their portion. Pima County has no plans to upgrade road conditions (David Cummings, *personal communication* to Brian Powell, January 2018).

The existing roadbed is vulnerable to erosion from flooding and it is conceivable that there are a number of places where the roadbed may need to be modified or reconstructed to better convey water. If future realignments of the road are undertaken by Pima County, and the modifications or repairs encroach further into parts of the Planning Area that has restrictive covenants, the Pima County Board would need to certify that such alignment achieves public safety purposes based on "clear and convincing evidence."

In addition to the present roadway, a separate right-of-way runs parallel to the current road, but is higher on the mesa. This right-of-way remains undisturbed desert scrub. In 1988, the state of Arizona abandoned the right-of-way and dedicated it to Pima County because the proposed Benson-Mammoth highway was never constructed. The right-of-way is a total of 200 feet wide, and runs parallel to and separate from the existing road in the Planning Area. The portions that lie within the Planning Area are encumbered by restrictive covenants, which means that the right-of-way within the Planning Area could not be used without a decision that it is needed for public health and safety based on "clear and convincing evidence" presented to the Pima County.

4 Natural Resources Targets: From Threats to Potential Actions

Effective natural resources planning requires identification of management actions that directly address or improve the resources or issues of interest. Chapter 2 of this plan provides an overview of the framework used to identify Targets for the Planning Area. This chapter articulates eight key features of each target:

Target Scope

- This is the area where the Target is best expressed or where Pima County management actions may be most effective. For some Targets, the scope is larger than the Planning Area.

Justification

- Why the Target was chosen including its ecological role or special status.

Management Goal

- What is hoped to be achieved by way of improving the Target. Note: This is different from management objectives, which focus on *how* an outcome can be achieved.

Objectives

- How a conservation outcome can be achieved. In the context of this management framework, objectives can be broader than the host of management actions specific to Pima County's purview at Bingham. These broad objectives are meant to both provide context to the actions that Pima County can implement as well as a reminder that improvement of Targets often requires coordination with other entities. For some Targets, objectives for monitoring and management are separated.

Threats

- Human-caused disturbances to the Targets. Common threats include development, groundwater pumping, and habitat fragmentation.

Stressors

- Attributes of a Target that are impaired directly or indirectly by threats.

Recommended Actions

- These are actions that Pima County will—as resources permit—attempt to achieve during the term of the plan, and which are not contingent on the cooperation of agencies or individuals outside Pima County government

Management Opportunities

- These are actions, which are contingent on cooperation of agencies or individuals outside Pima County government.

4.1 Wildlife Habitat Connectivity

Target Scope

- Lower San Pedro River Valley, but focused on a buffer around the Planning Area.

Justification

- Wildlife habitat connectivity is a key conservation Target for Pima County and fragmentation of natural areas near to the Planning Area could impact this Target.

Management Goal

- Maximize wildlife habitat connectivity to and through the Planning Area (Fig. 4.1).

Management Objective

- Preserve and enhance sustainable ecosystem functions within the Preserve and connectivity to surrounding open space for endemic local wildlife.

Monitoring Objective

- Monitor activities that conflict with the restrictive covenants.

Threats

- Subdivision and development (including road building, and utility lines or other infrastructure);
- Groundwater pumping; and
- Fencing.

Stressors

- Lower and rapidly fluctuating groundwater levels;
- Loss of wildlife habitat and movement corridors; and
- Changes in hydrology.

Recommended Action

- Complete inventory of fencing in and around the Planning Area, including new acquisitions;
- Remove or modify hindrances to wildlife movement in the Planning Area:
 - Ensure correct fencing wire spacing and type (i.e., smooth wire on top and bottom) to meet wildlife-friendly fence standards;
 - Remove unneeded fencing to improve permeability for wildlife movement.
- Maintain diversity of sustainable vegetation cover types including open woodland and bosque, to provide migratory bird stopover habitat (see vegetation objectives and actions); and
- Maintain wildlife access to one or more ephemeral or perennial ponds.

Management Opportunities

- Work with adjacent large land owners to explore Conservation Easements;
- Stay engaged with the conservation entities in the area (e.g., Cascabel Conservation Association, NRCO, TNC, etc.) through continued Pima County participation in the Lower San Pedro Collaborative Group;
- Oppose efforts to pave the Redington Road;
- If San Pedro River Road. is proposed to be modified, comment on proposals, solicit avoidance, minimize and mitigate impacts in the Planning Area, and monitor effects, per the MSCP; and
- Consider purchasing additional land with high-value cuckoo habitat along the San Pedro River if it can improve durability of connectivity through the existing properties.

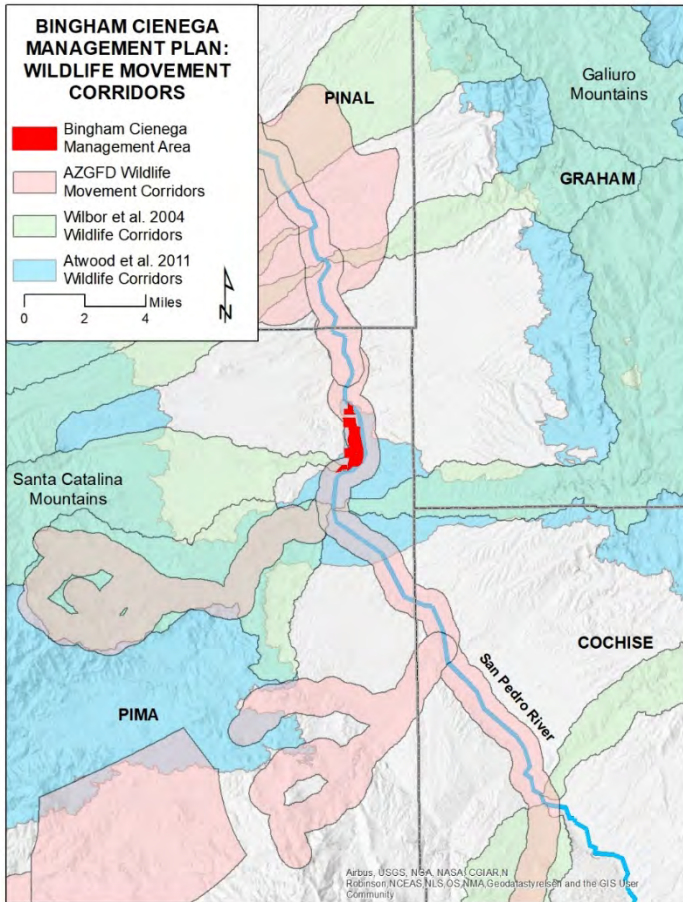


Figure 4.1 Wildlife movement corridors in the San Pedro Valley (Atwood et al. 2011; Wilbor 2014).

4.2 Mesquite Bosque and Other Priority Plant Communities

Target Scope

- Planning Area.

Justification

- Mature and/or dense mesquite dominated woodlands, broadleaf riparian forests, remnant wetland areas, and certain nesting trees provide critical habitat for a variety of MSCP covered species. For this plan, connectivity for the yellow-billed cuckoo was used to prioritize areas of mesquite for conservation. Other areas support buttonbush, a rare wetland plant, and yerba mansa, an uncommon riparian obligate (Figure 4.2). The buttonbush population contains some of the largest observed individuals known in the region. These priority areas provide both important habitat resources and connectivity for many species of wildlife in Bingham Cienege.

Goal

- Maintain native plant communities appropriate to the site’s hydrological conditions. Promote management actions around priority plant communities in light of site protection concerns.

Threats

- Groundwater pumping;
- Climate change; and
- Development and habitat fragmentation.

Stressors

- Lower and rapidly changing groundwater levels;
- Wildland fire; and
- Fire management activities (brush clearing, tree removal);
- Invasive species.

Management Objectives

- Maintain priority areas of mesquite bosque (Fig. 4.2);
- Maintain and support buttonbush and yerba mansa population at the Bingham Cienega wetland (Fig. 4.2);
- Minimize impacts to nesting birdlife by maintaining trees including snags, as defined through mapping; and
- Maintain priority isolated broadleaf riparian and cienega patches.

Monitoring Objectives

- Monitor acres of live mesquite and dead mesquite-dominated areas;
- Monitor change in gallery riparian trees: spatial extent, structure, and condition;
- Monitor extent of yerba mansa populations; and
- Monitor extent of buttonbush at the cienega.

Recommended Actions

- Authorize research as it relates to a potential technique for improving bosque condition, history, or management (ongoing);
- Complete the baseline vegetation community extent and condition (ongoing);
- Describe condition/viability of mesquite-dominated areas (ongoing);
- Complete the plant list for the Planning Area (ongoing);
- Analyze imagery for change in vegetation (planned);
- Conduct field inventory of nesting trees (ongoing);
- Map any isolated riparian species sites or patches (ongoing); and
- Incorporate nest-avoidance measures into existing fire management activities (see fire).

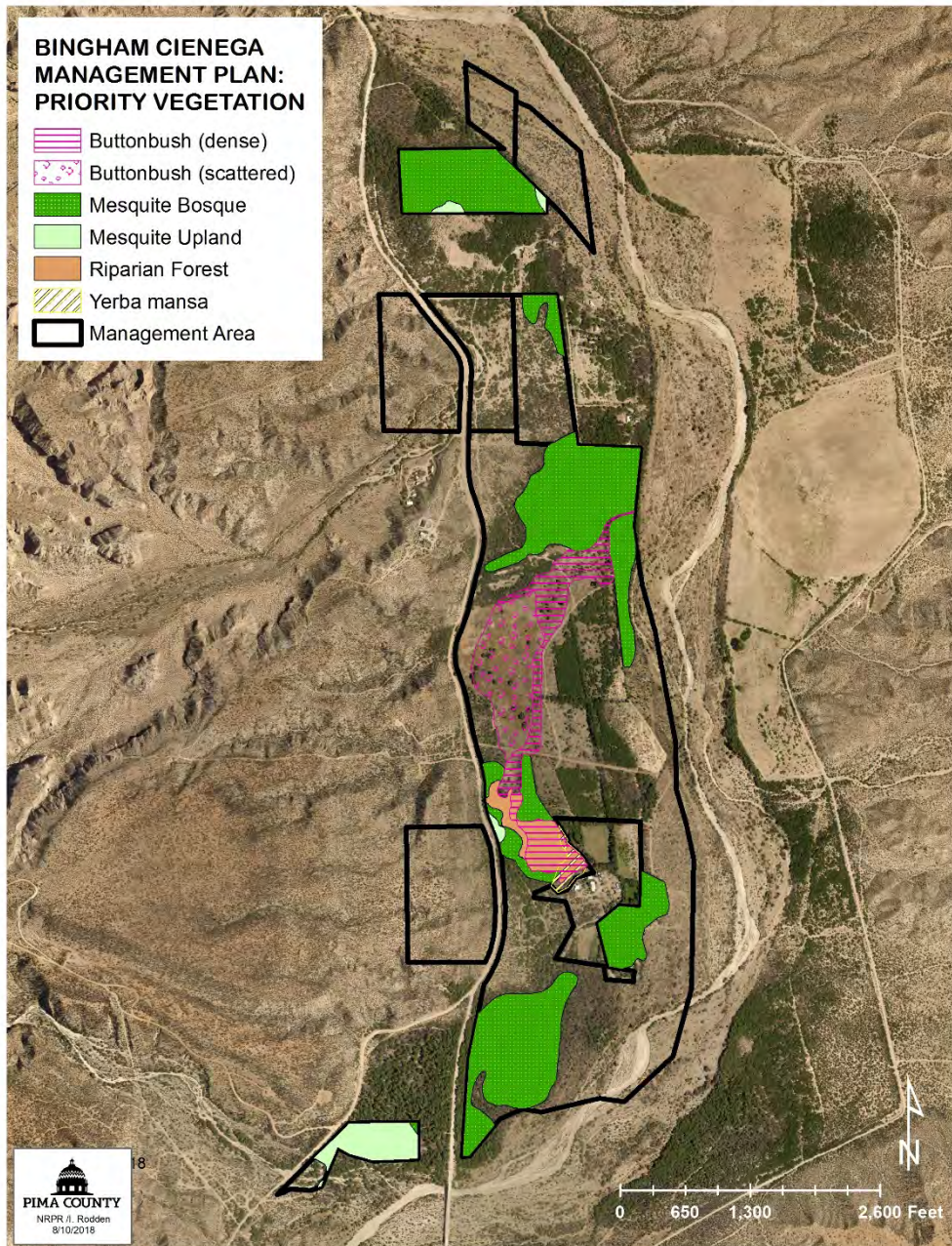


Figure 4.2. Priority vegetative areas for conservation.

4.3 Native Aquatic Species

Target Scope

- Suitable habitat in the Planning Area.

Justification

- Aquatic species are an important element in the MSCP and the Planning Area provides opportunities to create breeding habitat for select species.

Goal

- Maintain or improve habitat in the Planning Area for four MSCP covered species: Huachuca water umbel, lowland leopard frog, Mexican garter snake, and Gila topminnow (target species).

Management Objective

- Provide perennial aquatic habitat for the four species at locations to be determined in the future. Opportunities for the garter snake are dependent upon first having a robust lowland leopard frog population;
- Leave downed woody debris in locations close to standing water to provide habitat for the Mexican garter snake, where such actions do not appreciably increase fire risk; and
- Reduce non-native species threats to lowland leopard frogs and other target species.

Monitoring Objective

- Monitor water quality and quantity and presence of non-native aquatic species to ensure it's appropriate for the target species;
- Evaluate the pond for size, capacity and water retention.

Threats

- The privately managed artificially sustained pond could be breached, washed out, or abandoned. The pond is not yet Pima County-managed because of the Life Estate status;
- Bullfrogs and other non-native species (e.g., bass) using the existing open waters.

Stressors

- Continued groundwater decline, prohibiting access to groundwater needed to fill the pond.

Recommended Actions

- Re-evaluate pond use after Life Estate is served;
- Investigate feasibility and desirability of maintaining an additional or alternate pond, perhaps near the springhead, near the yerba mansa, or other sites where water could be maintained;
- Consider how pumping at onsite wells and water spreading at orchard impacts aquatic species Targets;
- Evaluate habitat needs for Huachuca water umbel at the pond and former springhead. If conditions for reintroduction are present, work with the USFWS;
- Manage non-native species that impact lowland leopard frog and other target species; and

- Consider native aquatic species habitat needs and introduce native aquatic species as permissions, needs, and resources permit.

4.4 Shallow Groundwater and Surface Water Discharge in the Planning Area

Target Scope

- The shallow groundwater system of the lower San Pedro River in and around the Planning Area, as distinct from the tributary watersheds coming from the Catalina Mountains.

Justification

- Recharge and pumping along the San Pedro affect groundwater levels at Bingham, which in turn drive aquatic and riparian features and functions. The shallow groundwater system could again support base flows in the river and at the Bingham Cienega wetland.

Goal

- Help create conditions for restoration of shallow groundwater levels in and around the former wetland, and for an increased extent of moist soil in the Bingham Cienega wetland.

Management Objectives

- Where possible, increase the extent or duration of moist soil conditions at the Bingham Cienega wetland over baseline; and
- Minimize stressors that Pima County has control over as in minimize groundwater pumping where such pumping is not needed to maintain the Targets.

Monitoring Objectives

- Monitor changes in groundwater levels near the former wetland that could signal change in vegetation communities;
- Monitor the extent and location of moist soil and surface extent onsite during the winter when evapotranspiration is lowest;
- Quantify seasonal, onsite water uses (after end of Life Estate);
- Monitor or record irrigation practices at the orchard. Attempt to understand if irrigation at the orchard contributes or detracts from moist soil conditions at the springhead; and
- Periodically re-evaluate natural recharge trends on San Pedro River based on Redington gage records in relation to moist soil and surface water extent, if any.

Threats

- Groundwater pumping;
- Impairment of recharge functions along the San Pedro River due to fine sediment and ash; and
- Road construction cutting off tributary flow.

Stressors

- Declining and low groundwater table;
- Historic incision, caused reduction of frequent overbank flows;

- Inappropriate sediment balance;
- Increased water demands due to warm temperatures, longer growing season (climate); and
- Decreased precipitation in upstream riverine and mountainous watersheds.

Recommended Actions

- Better understand role of nearby groundwater pumping in the San Pedro River in affecting on-site shallow groundwater levels; and
- Continue monitoring to determine if shallow groundwater trends are reversed.

Management Opportunities

- Purchase and retire water rights or reduce pumping in collaboration with others;
- Evaluate the potential for water-spreading in the San Pedro River to enhance recharge, in cooperation with others;
- Install water meters on existing wells.

4.5 Tributary Streamflow and Recharge from Outside the Planning Area

Target Scope

- Contributing secondary watersheds (Edgar, those along Six-Bar Ranch Road, Buehman, A7 Ranch [Fig. 4.3]) outside the Planning Area that are managed by Pima County.

Justification

- Tributaries have been shown through isotope analyses to contribute a large percentage of surface water and subflow to groundwater levels at Bingham.

Goal

- Protect tributaries known to contribute groundwater recharge to Bingham Cienega (Buehman, Edgar, Soza, Youtcy and Espiritu in A7 Ranch).

Management Objectives

- Provide the optimal conditions for shallow groundwater recharge in the Planning Area by employing sound management in the contributing watersheds including protection of tributaries; and
- Minimize impacts of any future road activities on tributary on-flows to the Planning Area.

Monitoring Objectives

- Monitor miles of streamflow (June in Edgar, Youtcy, Buehman), and rainfall; and
- Depth to groundwater levels at key wells in the Planning Area: Edgar, Youtcy, and Buehman watersheds.

Threats

- Catastrophic wildfires followed by floods (scour, sedimentation, ash);
- Climate change (high temperatures, lower precipitation, particularly winter with loss of snowpack);
- Excessive grazing removing watershed cover and increasing erosion;
- Loss of funding from the Coronado National Forest for restoration and management activities in upper tributary watersheds; and
- Excessive groundwater use;

- Mining.

Stressors

- Drought;
- Lower infiltration rates due to fine sediment moving into tributaries, impeding recharge; and
- Increased fine sediment or reduced water supply due to road repairs or re-construction.

Recommended Actions

- Identify the potential to improve water infiltration and inflow to the former Bingham Cienega wetlands in the small watersheds along the Six Bar Ranch Road that flow across San Pedro River Road and Edgar Canyon watershed (Fig. 4.3);
- Identify in-channel treatments in tributaries to Bingham Cienega to slow flows and promote infiltration;
- Consider measures to minimize loss of soil on highly erodible portions of M Diamond and other Pima County-managed ranch lands in grazing management planning; and
- Consider installing flow- or soil-moisture sensors in key tributaries under Pima County management, with objectives to measure progress.

Management Opportunities

- Communicate with Coronado National Forest regarding land management planning and actions (e.g., firescape, prescribed fire) in upper tributary watersheds designed to minimize catastrophic fires and improve watershed infiltration;
- Support management efforts in maintaining appropriate fire intervals in the respective tributary watersheds to reduce impacts from catastrophic flooding;
- Work with Cochise County Transportation Planning and their contractor to minimize impacts of road repairs along San Pedro River Road; and
- Consider acquiring land if this will protect important tributary water supplies for the Planning Area.

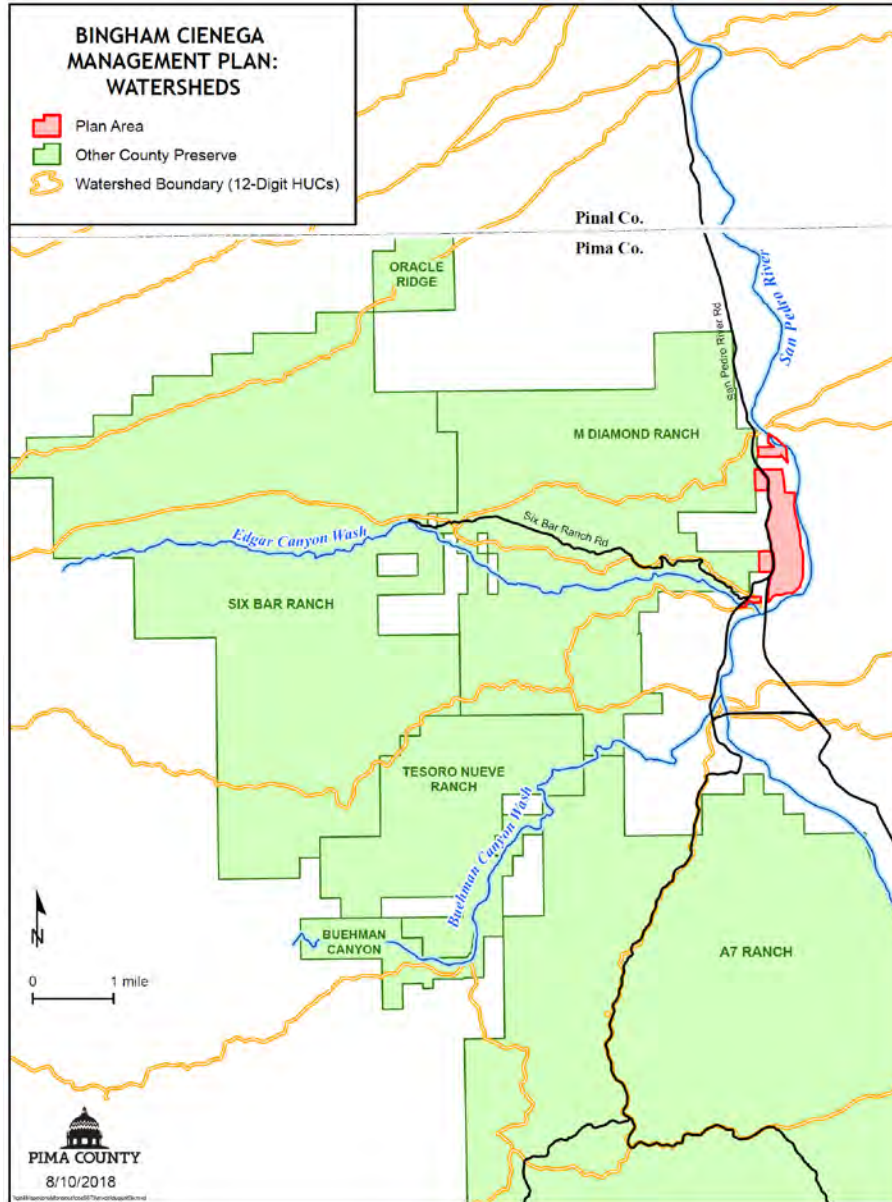


Figure 4.3. Tributary watersheds under Pima County management include small watersheds along the Six Bar Ranch Road that flow directly toward Bingham, as well as Edgar and Buehman canyons. On A7 Ranch, Espiritu, Youtcy and Soza canyons also contribute inflows to the San Pedro River upstream of the Planning Area.

5 Other Management Topics

5.1 Fire Management

Target Scope

- Planning Area.

Justification

- The current drought has created conditions that threaten public safety, residential infrastructure and key natural and cultural resources.

Goals

- Ensure public and caretaker safety;
- Protect historic structures; and
- Prevent catastrophic fire to maintain vegetation and cultural resources.

Threats

- Fires related to non-permitted use;
- Accidental fires originating from mechanical devices or other equipment operated by caretaker(s), managers, or permitted visitors;
- Lightning; and
- Electrical utility line breakage.

Stressors

- Drought, heat, wind; and
- Increasing fuel loads/deadfall vegetation.

Management Objectives

- Ensure conformance with TNC Conservation Easement terms for fire breaks on the residential inholding;
- Ensure conformance with the MSCP Restrictive Covenants regarding alteration of natural vegetation outside the Life Estate;
- Assure managers and caretakers prioritize fire awareness and preparation;
- Emphasize maintaining safety as well as site management objectives for habitat and connectivity; and
- Provide water source(s) for as-needed local fire fighting within and adjacent to the Planning Area.

Inventory/Monitoring Objectives

- Identify vegetation conditions that could lead to wildfires using periodic evaluation of vegetation conditions around buildings and along fire breaks (Figure 5.1).

Recommended Actions

- Determine how structures in the Life Estate will be integrated into public safety;
- Provide quarterly visual inspections and bi-annual vegetation assessments for fine and coarse fuels (ongoing);
- Periodic inspection of the inholding for storage of flammables and other safety practices (ongoing);
- Manage vegetation overgrowth within 50 feet of historic structures per TNC Conservation Easement (at fruition of Life Estate);

- Maintain existing fire breaks based on need, up to a 50-foot width in highest risk areas and more typically 12-foot to 25-foot width in lower within the risk areas, depending on site conditions and property limits (see orange lines on Fig. 5.1 and monitoring objectives above);
- Identify emergency access and/or evacuation routes and location of available water sources for suppression activities;
- Educate future caretakers on fire risk reduction and safety practices;
- Designate parking areas to minimize fire risks;
- Maintaining utility line by clearing woody limb grow-ins;
- As necessary, fuels treatment within existing fuel breaks (orange on map below), which could include targeted grazing to reduce fine fuel levels;
- Identify any new fuel breaks outside the Life Estate for approval by the Board; and
- Consult with qualified experts on fire management, as appropriate.

Management Opportunities

- Incorporate Bingham fire management strategies into multi-partner, landscape-level plan(s).

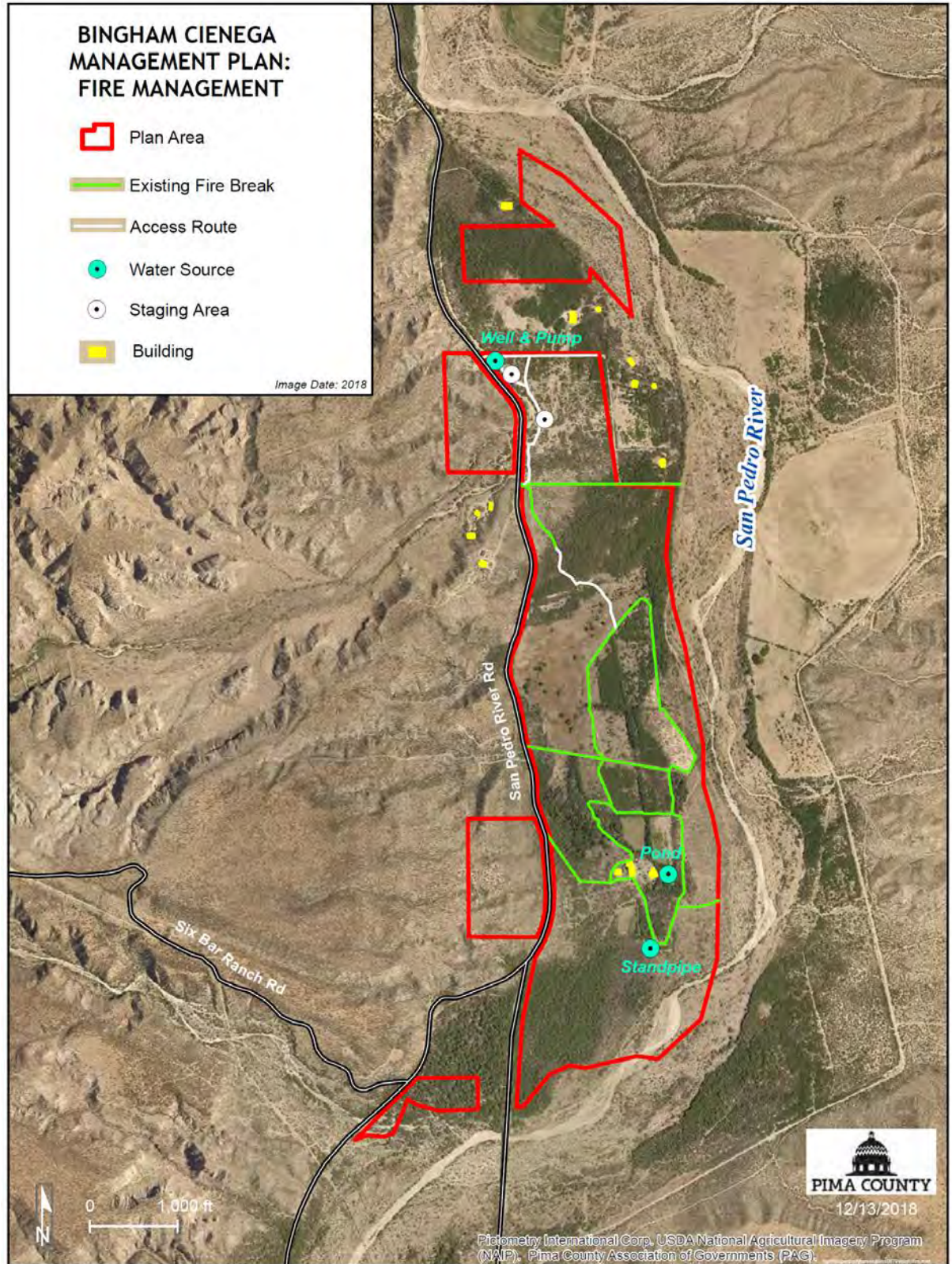


Figure 5.1. Fire infrastructure within the Planning Area

5.2 Site Protection

Target Scope

- Planning Area.

Justification

- Provide for protection of resources at this remote site.

Goals

- Ensure future uses are consistent with Conservation Easement or Restrictive Covenants, where applicable; and
- Provide for care of on-site resources and facilities by future caretakers or other Pima County agents

Threats

- Disturbance to covered species occupying the site;
- Vandalism, especially if there are periods of non-occupancy; and
- Woodcutting or other resource damage by unauthorized uses.

Management Objectives

- Ensure continuous occupancy of residence by persons with caretaking responsibilities;
- Discourage inappropriate use by caretakers and other authorized agents such as utilities, contractors, other Pima County departments, scientists;
- Ensure conformance with MSCP Restrictive Covenants regarding the prohibition against off-road vehicular travel outside the Life Estate, except to facilitate permitted activities; and
- Ensure conformance with MSCP Restrictive Covenants and TNC Conservation Easement regarding the granting of access, rights-of-way, or easements for new roads or new utilities, except where Pima County has no discretion to prohibit the activity.

Recommended Actions

- Identify expectations for caretaker responsibilities on the property and write those into the caretaker agreement; define scope of minimum and desired caretaker responsibilities with respect to site protection and conformance with the Conservation Easement;
- Maintain access control by gates, fences and informational signage;
- Repair wildlife-friendly fencing as needed (Fig. 5.2);
- Periodically inspect the gates, fences, and signage;
- Provide biennial inspection reports for parcels with Restrictive Covenants;
- Consider encumbering additional parcels located in the Planning Area with Restrictive Covenants; and
- Review proposals for new uses for consistency with Conservation Easement or Restrictive Covenants.

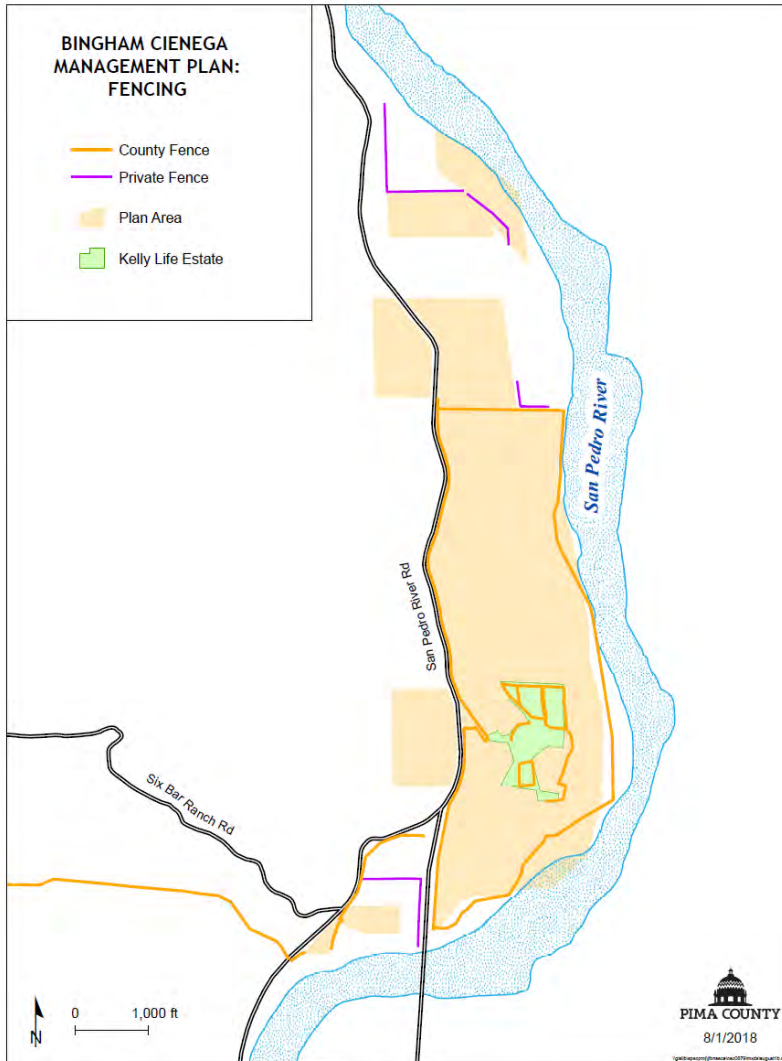


Figure 5.2. Fencing in the Planning Area.

5.3 Public Use

Target Scope

- Planning Area.

Justification

- Protect resources at this remote site and be prepared to respond to requests from the public demand to visit the site for passive recreation or tours.

Goals

- Ensure that any public use does not interfere with best land management practices, MSCP goals, habitat functions, and security;
- Ensure that any public use does not interfere with our agreements regarding the Life Estate or their right to privacy;
- Encourage public awareness of natural and cultural resources along the Middle San Pedro River; and
- Ensure public adherence to Park Rules.

Threats

- Disturbance to covered species occupying the site from unauthorized public use;
- Woodcutting, vandalism or other resource damage.

Management Objectives

- Discourage inappropriate use by public, vehicles, and livestock; and
- Ensure conformance with MSCP Restrictive Covenants and TNC Conservation Easement regarding public use.

Recommended Actions

- Do not open or facilitate access to the river bottom;
- Access to District land is by permit/written permission only;
- Access to Pima County parcels west of the San Pedro River on the mesa should not be encouraged due to resource sensitivity and lack of staffing;
- Provide users with information about use restrictions that may derive from park rules, Restrictive Covenants and/or the Conservation Easement;
- Identify public safety needs that related to public use; and
- Adhere to avoidance and minimization measures in MSCP Section 5.1.4.

Management Opportunities

- Periodically evaluate the opportunity and need to improve the safety of residents, staff and visitors from recreational firearms use.

5.4 Non-Native Species

Target Scope

- Planning Area.

Justification

- Non-native species can threaten the structure and function of biological communities within the Planning Area.

Key Threats

- Tumbleweed, Johnson grass, bur bristle grass, shrubby tamarisk, feral pigs, bullfrogs, and non-native fish.

Goals

- Manage or minimize the impacts of non-native species that threaten Targets;
- Integrate management of relevant non-native species into fire management; and
- Integrate management into the aquatic species plan in the case of bass, carp and sunfish.

Management Objectives:

- Periodically re-evaluate the threats and any apparent impacts of existing non-native plants and animals on the Targets.

Inventory/Monitoring Objectives

- Implement a non-native plant early detection protocol tied to routine site inspections; and
- Monitor for new non-native aquatic species.

Recommended Actions

- Control non-native plants that threaten the Targets, where feasible; and
- Manage non-native species that impact lowland leopard frog, native fish, and Mexican garter snake (after Life Estate is served).

Management Opportunities

- Cooperate with San Pedro landowners and with state and federal agencies on feral pig control.

5.5 Cultural Resources

Target Scope

- Planning Area.

Justification

- The cultural resources survey has verified the locations and provided updates on the conditions of five previously recorded archaeological and historic sites. This survey has identified six additional archaeological or historic sites on the property. In total, 11 archaeological and historic sites have been identified. In many cases, the current conditions of each site have been recorded and indicate changing conditions creating negative impacts to cultural resources on this property. These conditions include evidence of pothunting, modern land use, and erosion. Measures to protect these sites from further damage should be considered and implemented in the management of cultural resources. The protection of cultural resources can help perpetuate a sense of place and significance of land use through time.

Goals

- Maintain the integrity of historic, standing structures and other features (e.g., irrigation features, wells, corrals, windmill);
- Preserve archaeological sites and traditional places of significance;
- Preserve oral history (historical ranching families); and
- Preserve ethnographic knowledge (Tribal input) relevant to the Planning Area.

Management Objectives

- Preserve a sense of place in terms of cultural landscape for Native Americans and families who value perpetuation of ranch traditions;
- Identify and preserve historical structures that contribute to the historic significance of the landscape and to keep these buildings from falling into disrepair; and
- Preserve archaeological sites.

- Inventory/Monitoring Objectives:

- Understand how the land was used in the past and how land use changed through time;
- Understand the cultural history of the land and how Tribes currently characterize the landscape;
- Identify potential for *Agave sanpedroensis* and, if identified, inventory and monitor;

- Monitor physical changes in the landscape;
- Identify sensitive areas that may be susceptible to natural or human threats;
- Monitor significant historical structures;
- Monitor archaeological sites; and
- Identify low-impact ways to minimize threats to the cultural resources.

Threats

- Mechanical land disturbance including road or path widening, new utilities and other site development activities;
- Pedestrian/ATV traffic;
- Loss of traditional knowledge;
- Vandalism of archaeological sites or theft of artifacts; and
- Erosion.

Stressors

- Excessive runoff from the road;
- Ground disturbance (e.g., from utilities, roads, etc.);
- Neglect or vandalism of historical structures and features; and
- Flooding, erosion and geological processes.

Recommended Actions

- Archival research and organizing/transcribing oral histories of past land use practices (ongoing);
- Identify cultural resources through pedestrian survey, archival research, oral history, ethnographic studies and Tribal collaboration (ongoing);
- Continue evaluating and monitoring structures identified as historically significant;
- Consider rehabilitation of historically significant structures; and
- Recommend practices and priorities for minimizing activities that may cause cultural resources damage in or near the sites.

5.6 Visual Resources

Target Scope

- Planning Area and San Pedro River Road corridor.

Justification

- Maintain a sense of place and scenic values. Visual resources are also important factors affecting wildlife use.

Key Resources

- Residence and homestead area, bosque, wetland, traditionally significant areas.

Goals

- Protect and maintain the visual character of the landscape that contributes to a sense of place; and
- Minimize visual alterations that would impair wildlife use or connectivity.

Threats

- Adjacent or onsite land uses that introduce new elements inconsistent with the predominantly natural or rural character;
- Nighttime lighting that impairs wildlife use or connectivity;
- San Pedro River Road corridor activities that affect natural or rural character; and
- Large fires, drought-induced mortality, or clearings that affect natural or rural character.

Management Objectives

- Minimize nighttime lighting impacts to wildlife;
- Minimize visual impacts from San Pedro River Road corridor activities; and
- Minimize visual impacts to views of natural vegetation from San Pedro Road.

Inventory/Monitoring Objectives

- Identify sensitive areas that may be threatened and evaluate needs and ways those visual resources can be maintained;
- Monitor low-impact land uses over time; and
- Monitor adjacent land use over time and how it affects visual characteristics.

Recommended Actions

- Create a map locating visual resources (buildings and natural elements) that are physically represented on the landscape and a radius (yet to be determined) showing adjacent land uses and current infrastructure;
- Review nighttime lighting fixtures after Life Estate is served; and
- Review new proposals for buildings or other infrastructure at the site to minimize changes to natural or rural character, consider use of screening vegetation, paint colors that blend into landscape. Modifications to natural and physical elements (i.e. ponds, structures, vegetation, and species) should harmonize with the visual resource goals.

5.7 Ranch Resources

Target Scope

- Planning Area in relation to contributing watersheds of M Diamond, Six Bar and A7 ranches.

Justification

- Maintain working landscape, food production and a presence on the land and in the community.

Key Resources

- The two M Diamond parcels west of San Pedro River Road, the residence and homestead area, working livestock facilities, wells and water.

Goals

- Support NRPR's need for a ranch lessee for M Diamond ranch by looking to make portions of the Planning Area available to support ranch activities;
- Respect the Life Estate on the 19-acre inholding, and continue to manage and occupy the residence after the completion of the Life Estate; and

- Manage farm and ranch operations to meet all targets, goals and objectives in the Planning Area including the future associated Ranch Resource Management Plans.

Threats

- Loss of M Diamond, A7, or Six Bar state trust lease could adversely affect water and sediment conditions affecting Bingham Cienega;
- Loss of maintenance to existing infrastructure at Bingham if ranch use is discontinued;
- Loss of potential community members, food production and presence on the land; and
- Increased adverse grazing from adjacent ranches.

Management Objectives

- Implement grazing plans for contributing watersheds that provide for the Planning Area goals;
- Incorporate targeted grazing, where livestock can be used to achieve vegetation and fuels management objectives, in the Planning Area where and when appropriate, and integrate relevant information into the fire and fuels management plan;
- Limit or discontinue commodity crop production on irrigated areas and allow irrigation for low water use niche crops, vegetables, and orchard for the house residents. Do not expand the orchard or field areas.
- Monitor permanent water sources to determine how much is available to meet livestock and Planning Area objectives without increasing pumped water per MSCP restrictive covenants;
- Monitor utilization and long-term vegetation trend in actively grazed areas of the Bingham Planning Area using the Pima County Range Management Standards and Guidelines;
- Work closely with the future M Diamond Ranch lessee to ensure that livestock grazing plans are coordinated with all other Planning Area management activities;
- Residence occupant will care take all buildings, farm, ranch and conservation infrastructure, and is permitted to use the small field and orchard for food. This individual or organization could be the ranch lessee or the Bingham caretaker; and
- Avoid impacts to cultural resources from ranch activities in the Planning Area.

Inventory/Monitoring Objectives

- Monitor effectiveness of any prescribed grazing to minimize fine fuels at Bingham Cienega; and
- Compare alternative means of hazard reduction for fine fuels to prescribed grazing for fuels management.

Recommended Actions

- Complete fence condition inventory;
- Maintain ranch inventory data;
- Establish monitoring transects based on soil types and ecological sites for Planning Area as part of the M Diamond Ranch, and determine extent of departures from reference condition, if any, to learn current states of ecological sites;

- Make available the two parcels west of San Pedro River Road for grazing as part of M Diamond Ranch;
- Identify appropriate livestock holding and grazing methods in the Planning Area, including seasons of use and planning efforts;
- Include the Planning Area, the M Diamond Ranch State Lease and associated Pima County-owned fee lands in future M Diamond Ranch planning; and
- Carefully plan how the Life Estate area will be occupied and managed as part of, or not part of, the M Diamond Ranch.

6 Acknowledgements

Pima County would like to thank Jack and Lois Kelly, who have provided Pima County with the opportunity to provide stewardship to this area. The Kelly family provided a great deal of information that improved our understanding of the resources and their relationships to past and present uses, and they continue to care for the land. Jess Barry of Pima County has been an essential part in the transfer of this intergenerational knowledge.

The authors thank TNC for their past site management efforts with special thanks to Barbara Clark for many years of service; Bob Rogers for his expertise in fire preparedness; Bob Rogers and Dale Turner for sharing their knowledge about the San Pedro watershed and TNC's framework for conservation planning; and Dale Turner for completing field work at Bingham Cienega that provided insights about young mesquite forests. Diana Imig and Celeste Andresen also provided background information. Carolyn Leung at Pima Association of Governments kindly provided census data.

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Appendix A. MSCP Master Restrictive Covenant

Master Restrictive Covenant for Pima County MSCP Mitigation Land

This Master Restrictive Covenant ("**MSCP Master Covenant**") is entered into by Pima County, a political subdivision of the State of Arizona ("**County**"), the Pima County Regional Flood Control District, a political taxing subdivision of the State of Arizona ("**District**"), and the Arizona Land and Water Trust, Inc., an Arizona nonprofit corporation ("**Beneficiary**") (County, District, and Beneficiary being collectively the "**Parties**").

1. Background and Purpose

1.1. The United States Fish and Wildlife Service issued permit #TE84356A to County (the "**Permit**") for the incidental take of threatened and endangered species caused by specific, lawful activities within Pima County. To direct the mitigation of these incidental takes and ensure compliance with the permit, the County has established its Multi-Species Conservation Plan ("**MSCP**"). The objectives of the MSCP (the "**Objectives**") include managing mitigation lands to prioritize conservation of Covered Species and their habitats, prevent landscape fragmentation, and support species establishment or recovery.

1.2. The County owns the real property listed in Exhibit A (the "**Restricted Property**" or "**Restricted Properties**"). A map identifying the Restricted Property is attached hereto as Exhibit B. Individual maps of each of the Restricted Properties are attached hereto as Exhibit C. The Restricted Property contains significant undisturbed natural open space that the County wishes to preserve and protect for the mitigation of incidental take covered by the County's incidental take permit.

1.3. The Parties intend this MSCP Master Covenant to prohibit uses of the Restricted Properties that would impair or interfere with the mitigation efforts of the County, except for any pre-existing uses as shown on imagery by Pictometry or Pima Association of Governments dated 2015 or 2016, whichever is more recent (the "**Pre-existing Uses**").

1.4. The Parties intend that this MSCP Master Covenant assure that the Restricted Properties will be forever preserved as natural open space for the conservation of natural habitat for wildlife, the protection of rare and unique native plants and animals and the scenic enjoyment of the general public.

2 Recording of Site Specific Restrictive Covenants

2.1. The Parties intend that a site specific agreement ("**Site Specific Agreement**") be recorded for each individual property listed on Exhibit A and depicted on Exhibits B and C. The Site Specific Agreement shall be in the form of Exhibit D attached hereto. The Parties intend that each Site Specific Agreement incorporate all of the terms and conditions contained in this MSCP Master Covenant. Each Site Specific Agreement will contain the legal description of the referenced property, and recordation of a Site

Specific Agreement will subject the real property described therein to the terms of this MSCP Master Covenant and cause such property to be a Restricted Property.

2.2. County hereby delegates to the County Administrator or his designee the authority to sign each of the Site Specific Agreements on behalf of County. District hereby delegates to the General Manager of the District or his designee the Authority to sign each of the Site Specific Agreements on behalf of District.

3. Nature of MSCP Master Covenant

3.1. This MSCP Master Covenant runs with each Restricted Property and binds the County and its successors and assigns.

3.2. This MSCP Master Covenant remains in perpetuity with respect to each Restricted Property, unless released by written consent of County, District, and Beneficiary, with the written concurrence of the U. S. Fish & Wildlife Service. Any release will specify if it relates to a specific Restricted Property or to this Master Agreement and, therefore, all the Restricted Properties.

3.3. The uses of the Restricted Properties prohibited by this MSCP Master Covenant remain in effect notwithstanding any future annexation of all, or any portion, of a specific Restricted Property by a municipality.

3.4. This MSCP Master Covenant may not be amended or modified except upon written agreement of County, District, and Beneficiary, and written concurrence from the U.S. Fish and Wildlife Service.

3.5. This MSCP Master Covenant may be enforced by District or Beneficiary as provided in Section 9 below.

4. **The Restrictions.** Except as provided in Section 5 of this MSCP Master Covenant, the following uses of the Restricted Properties are prohibited (collectively the "Restrictions"):

4.1. Development of the Restricted Properties, including subdividing or lot splitting of a Restricted Property;

4.2. Construction or placement of new or additional buildings or structures on a Restricted Property, unless the construction supports the purposes for which the Restricted Property was originally intended including any adopted master plan, and does not degrade the Restricted Property's values as expressed in the purpose statement;

4.3. Alteration of the ground surface or natural vegetation, except as may be needed for ranch, range improvement, or trail-based recreational uses, and only if such alterations are consistent with other provisions of the Multi-species Conservation Plan;

4.4. Impoundment, diversion or alteration of any natural watercourse unless for watershed enhancement to improve species habitat or to maintain a Restricted Property's mitigation values;

4.5. Development of, or the granting of, access, rights-of-way or easements for new roads or new utilities, including telecommunications facilities, except where County has no discretion to prohibit the activity;

4.6. Filling, excavation, dredging, mining, drilling, exploration, or extraction of minerals, hydrocarbons, soils, sand, gravel, rock or other materials on or below the surface of the Restricted Property, except where County has no discretion to prohibit the activity;

4.7. Storage, accumulation or disposal of hazardous materials, trash, garbage, solid waste or other unsightly material on the Restricted Property;

4.8. Introduction of non-native fish or amphibians or other non-native animals to or from catchments, tanks, springs or creeks. Other non-native species that might adversely affect the mitigation of permitted activities are also prohibited except for the purposes of supporting existing ranching operations, if any, and limited to those areas identified that have historically been devoted to the growing of such species, as shown on 2015 or 2016 aerial photographs;

4.9. Storage and use of biocides and chemical fertilizers except for residential and agricultural purposes. Aerial application of biocide or other chemicals is prohibited except where County and District concur that it is an appropriate and necessary management technique to promote the recovery and re-establishment of native species, to reduce threats to ecosystem structure and function, or to protect public health, safety and welfare;

4.10. Pumping of water from existing diversions for purposes other than on-site residential, wildlife, recreational, habitat enhancement and agricultural uses associated with livestock grazing on the Restricted Property. Increases in the pumped amounts of surface or subsurface water as allowed by the Arizona Department of Water Resources are not permitted without joint approval from the County and District and concurrence from the U.S. Fish and Wildlife Service;

4.11. Installation of underground storage tanks for petroleum or other polluting substances, except for already existing or permitted septic tanks;

4.12. Confinement of livestock where animals are permanently located in enclosures and the majority of their feed supplied from outside sources. This includes feeder cattle, dairy, pig, poultry and exotic animal farm operations;

4.13. Commercial enterprises inconsistent with the Objectives, excluding farming and ranching. The County and District may jointly approve commercial enterprises, other

than farming or ranching, that provide for ecotourism or wildlife-related recreation provided that it is consistent with the Objectives and does not degrade the Restricted Property's mitigation value;

4.14. Residential use for mobile homes, travel trailers, tent trailers, self-propelled recreational vehicles and like structures or vehicles, except temporary use as permitted by County Park Rules or reasonable use as needed to support the protection or enhancement of the Restricted Property's mitigation value;

4.15. Paving of roads using asphalt or concrete except where required by County ordinance;

4.16. Any modification of the topography of the Restricted Property through the placement of soil, dredging spoils, or other material, except for those uses permitted under this document, or to reduce soil erosion or to protect public health, safety and welfare;

4.17. Severance of water rights appurtenant to the Restricted Property including the transfer, encumbrance, lease and sale of water rights;

4.18. Off-road vehicular travel except to facilitate permitted activities on the Restricted Property; and

4.19. Removal of natural, mineral, or cultural resources that is not authorized by County.

5. Exceptions to Restrictions. Notwithstanding any other provision of this MSCP Master Covenant, the following uses of the Restricted Properties are not prohibited:

5.1. Any use of the Restricted Property which the County Board of Supervisors in its reasonable discretion determines is necessary to retain, restore, or enhance the mitigation of incidental take covered by the Permit;

5.2. Any Pre-existing Use of the Restricted Property;

5.3. Any use of the Restricted Property expressly permitted by a contract in effect between the County and a third party as of the date this MSCP Master Covenant is recorded; and

5.4. Any use of the Restricted Property which the County Board of Supervisors determines, based on clear and convincing evidence presented to said Board, is necessary to protect the public health, safety or welfare.

6 Obligations of County

6.1. County, through its employees, agents and contractors, retains all responsibilities and will bear all costs and liabilities of any kind related to the ownership, operation, upkeep, and maintenance of the Restricted Properties. County remains solely responsible for obtaining any applicable governmental permits and approvals for any activity or use undertaken on the Restricted Properties. All such activity shall comply with all applicable Federal, state, and local laws, regulations, and requirements.

6.2. County, through its employees, agents and contractors, at County's expense, will conduct an inspection of the Restricted Properties at least biennially to determine if there are any violations of the Restrictions. The inspection will be completed by either examination of aerial photographs or by physical inspections with onsite photographs taken at the time of the inspections. The County will prepare and deliver copies of biennial reports ("Reports") of its inspections, which reports will describe the then current condition of the Restricted Properties inspected and note any violations of the Restrictions. Copies of the Reports will be provided to District and Beneficiary upon completion, and in no event later than October 15 of each biennial reporting year. County will maintain the Reports as County records in accordance with Arizona state law.

6.3. County shall report any violations of the terms of this MSCP Master Covenant to District and Beneficiary within 2 working days of County discovery and confirmation of any such violation. For purposes of this Section 6.3, the determination of what shall constitute a reportable violation of this MSCP Master Covenant shall be at County's reasonable discretion. However, County's determination of what is reportable pursuant to this Section 6.3 will not limit District or Beneficiary's right to enforce this MSCP Master Covenant as provided for in Sections 7, 8, and 9 of this MSCP Master Covenant.

6.4. The parties acknowledge that Beneficiary has no legal ownership interest in the Restricted Properties, and it is the parties' intent that the Beneficiary not undertake any responsibility or liability with respect to the Restricted Properties, other than liability related to Beneficiary's negligence ("Beneficiary's Negligence"), as more specifically limited below. Therefore, County agrees:

6.4.1. County (as indemnifying party) shall indemnify, defend and hold harmless, Beneficiary and its officers, directors, employees, agents, affiliates, successors and permitted assigns (collectively, "**Indemnified Party**") against any and all losses, damages, liabilities, deficiencies, claims, actions, judgments, settlements, interest, awards, penalties, fines, costs, or expenses of whatever kind, including attorneys' fees, that are incurred by Indemnified Party (collectively, "**Losses**"), arising out of or related to any third-party claim alleging:

6.4.1.1. breach or non-fulfillment of any provision of this Agreement by County, District, or County or District's personnel;

6.4.1.2. any negligent or more culpable act or omission of County, District, or County or District's personnel (including any reckless or willful misconduct) in connection with the performance of County, District, or County or District's personnel under this Agreement;

6.4.1.3. any bodily injury, death of any person or damage to real or tangible personal property caused by the negligent or more culpable acts or omissions of County, District, or County or District's personnel (including any reckless or willful misconduct);

6.4.1.4. any failure by County, District, or County or District's personnel to comply with any applicable federal, state or local laws, regulations or codes, including any failure related to their performance under this Agreement; or

6.4.1.5. any claim by any third party asserting a failure of Beneficiary to enforce Beneficiary's rights, or perform Beneficiary's duties, under this Agreement. County's obligation to indemnify Beneficiary against third party claims related to any failure of Beneficiary perform Beneficiary's duties, under this Agreement will not preclude County from replacing Beneficiary as provided in Section 8.5. Replacement of Beneficiary will be County's sole remedy for Beneficiary's breach of its obligations under this Agreement.

6.4.2. Beneficiary must give notice to County (a "**Claim Notice**") of any claim filed which may give rise to a Losses. Indemnified Party's failure to provide a Claim Notice does not relieve County of any liability, but in no event shall County be liable for any Losses that result directly from a delay in providing a Claim Notice, which delay materially prejudices the defense of the claim. County's duty to defend applies immediately after receiving a Claim Notice.

6.4.3. County may select legal counsel to represent Beneficiary in any action for which County has an obligation to indemnify, defend and hold harmless Beneficiary, and County shall pay all costs, attorney fees, and Losses.

6.4.4. County shall give prompt written notice to Beneficiary of any proposed settlement of a claim that is indemnifiable under this Agreement. County may settle or compromise any claim without Beneficiary's consent, so long as Beneficiary is not responsible for paying any Losses.

7 Obligations of District

7.1. District shall review any and all reports on potential violations of the Restrictions provided by County to District as required by this MSCP Master Covenant, at District's expense.

7.2. If the event of any action that may constitute a violation of the terms of this MSCP Master Covenant, District shall determine, in its reasonable discretion, whether to take any action to enforce the terms of this MSCP Master Covenant.

7.3. In the event that County desires to take action with respect to the Restricted Properties that may constitute a violation of this MSCP Master Covenant, County will obtain District's prior approval of such action, and District shall respond to any such request from County in a timely manner.

7.4. District and County will advise Beneficiary in writing of any non-privileged communications between County and District with regard to the matters referred to in Sections 7.2 and 7.3. District and County will also provide Beneficiary with copies of any written communications, in whatever form, between District and County with regard to the matters referred to in Sections 7.2 and 7.3.

8. Obligations of Beneficiary

8.1. Beneficiary shall review any and all reports provided by County to Beneficiary as required by this MSCP Master Covenant, at County's expense. County shall compensate Beneficiary for performing its actions under this Section 8.1 on a time and materials basis, pursuant to the terms of professional services contract entered into between County and Beneficiary (the "Services Agreement"). In the event (i) County and Beneficiary cannot agree upon the Services Agreement; (ii) the Services Agreement is terminated, for any reason; (ii) County fails to timely pay Beneficiary under the Services Agreement; or (iii) County materially breaches any other term of the Services Agreement, then Beneficiary will have the right to terminate its obligations under this MSCP Master Covenant by providing County and District ten days prior written notice.

8.2. If the event of any action that may constitute a violation of the terms of this MSCP Master Covenant, Beneficiary shall determine, in its reasonable discretion, whether to take any action to enforce the terms of this MSCP Master Covenant. Beneficiary shall be reimbursed for any expenses incurred by Beneficiary to enforce this Master Agreement in accordance with the Services Agreement.

8.3. In the event that County desires to take action with respect to a Restricted Property that may constitute a violation of this MSCP Master Covenant, County will obtain Beneficiary's prior approval of such action, and Beneficiary shall respond to any such request from County in a timely manner. Beneficiary shall be compensated for any services performed in response to any such request in accordance with the Services Agreement.

8.4. In the event Beneficiary is no longer able to perform its obligations under this MSCP Master Covenant, or no longer desires to serve as Beneficiary, then Beneficiary shall provide not less than sixty (60) days' notice to County. Beneficiary may designate a replacement Beneficiary subject to County's approval. In the event Beneficiary does not designate a replacement Beneficiary within 45 days' after delivery of the notice, then

period, or County fails to continue diligently to cure such breach until finally cured, the Enforcing Party may in any such event bring an action at law or equity to enforce the terms of this MSCP Master Covenant or to enjoin the breach by temporary or permanent injunction, and to recover any damages caused by the breach of the terms of this MSCP Master Covenant or injury to any protected uses or mitigation, including damages for any loss, and to require the restoration of any Restricted Property to the condition that existed prior to the injury.

9.7. In the event any action, suit or proceeding at law or in equity is instituted with respect to this MSCP Master Covenant, the Enforcing Party shall be entitled to reasonable attorneys' fees, expenses and court costs incurred if it is the prevailing party.

9.8. Nothing contained in this MSCP Master Covenant can be construed to entitle the Enforcing Party to bring any action against the County for any injury to or change in the Restricted Property resulting from causes beyond the County's control including unforeseeable acts of trespassers, fire, flood, storm, drought, pests, natural earth movement, vegetative disease, or resulting from any action taken by the County under emergency conditions to prevent, abate or mitigate significant injury to any Restricted Property resulting from such causes.

10. General Provisions

10.1. The laws and regulations of the State of Arizona govern this MSCP Master Covenant. Any action relating to this MSCP Master Covenant must be brought in a court of the State of Arizona in Pima County.

10.2. Unless the context requires otherwise, the term "including" means "including but not limited to".

10.3. Each provision of this MSCP Master Covenant stands alone, and any provision of this MSCP Master Covenant found to be prohibited by law is ineffective only to the extent of such prohibition without invalidating the remainder of this MSCP Master Covenant.

10.4. This instrument sets forth the entire Agreement of the County, District and Beneficiary with respect to this MSCP Master Covenant.

10.5. Any notice given under this MSCP Master Covenant must be in writing and served by delivery or by certified mail upon the other Parties as follows:

If to County: Office of Sustainability and Conservation
Attn: Director
Pima County Public Works
201 N Stone Ave., 6th FL
Tucson Arizona 85701

Bingham Management Plan

If to District: Regional Flood Control District
Attn: Director
Pima Works Building
201 N Stone Ave., 9th FL
Tucson, Arizona 85701

If to Beneficiary: The Arizona Land and Water Trust
Attn: Diana Freshwater, President
3127 N. Cherry Ave.
Tucson, Arizona 85719

The Parties have executed this MSCP Master Covenant by their duly authorized representatives.

COUNTY: PIMA COUNTY, a political subdivision of the State of Arizona:

Chair, Board of Supervisors

Date

ATTEST:

Robin Brigode, Clerk of Board of Supervisors

Date

DISTRICT: The Pima County Regional Flood Control District

Chair, Board of Directors

Date

ATTEST:

Robin Brigode, Clerk of Board of Directors

Date

Appendix B. 1989 Conservation Easement

TICOR TITLE INSURANCE COMPANY

L.K.
Bingham Cienega (Kelly), AZ
3/12/90
(orig on file)

DEED OF CONSERVATION EASEMENT

THIS GRANT DEED OF CONSERVATION EASEMENT, by and between JACK KELLY and LOIS BINGHAM KELLY, husband and wife, hereinafter referred to as the "Grantors," and THE NATURE CONSERVANCY, a non-profit corporation of the District of Columbia, hereinafter referred to as the "Conservancy."

WITNESSETH:

WHEREAS, the Grantors are the owners of certain real property in Pima County, Arizona, more particularly described in Exhibit "1" attached hereto and incorporated herein by reference, hereinafter referred to as "Grantors' Land"; and

WHEREAS, Grantors' Land currently remains in a relatively natural state and has significant ecological and open space values; and

WHEREAS, Grantors' Land adjoins the Bingham Cienega Nature Preserve owned by Pima County, and is a valuable element of the San Pedro River Drainage, which includes Grantors' Land, and its ecological values, including flora, fauna, hydrology and soils; and

WHEREAS, Grantors' Land provides significant relatively natural habitat, including mature mesquite woodland which provides important habitat for native wildlife and plants; and

WHEREAS, protection of the Grantors' Land will contribute to the ecological integrity of the Bingham Cienega Nature Preserve and thus protect a globally significant, relatively natural habitat for wildlife and plants;

WHEREAS, all of the natural elements and ecological values on Grantors' Land are of great importance to Grantors and the Conservancy, and to the people of Pima County and the State of Arizona, and are worthy of preservation; and

WHEREAS, Grantors, as owners in fee of Grantors' Land, own the affirmative rights to identify and preserve and protect in perpetuity its natural ecosystems and other significant relatively natural features; and

WHEREAS, Grantors desire and intend to transfer such rights to the Conservancy; and

EXEMPT FROM AFFIDAVIT OF PROPERTY VALUE PER ARS 42-1614, A-2.

THIS DOCUMENT IS BEING RECORDED TO REPLACE AND SUBSTITUTE THAT CERTAIN INSTRUMENT RECORDED IN DOCKET 8538 AT PAGE 2495 ON MAY 16, 1989.

Jh.
L.K.

WHEREAS, the State of Arizona has recognized the importance of private efforts towards preservation of natural systems in the state by the enactment of ARS Sections 33-271 to 33-276; and

WHEREAS, the Conservancy is a private organization organized to preserve and conserve natural areas and ecologically significant land for scientific, charitable and educational purposes, and is qualified under ARS Section 42-271 and under Section 170 (h) (3) of the Internal Revenue Code of 1954, as amended, to acquire and hold Conservation Easements;

NOW, THEREFORE, in consideration of the mutual covenants contained herein, based upon the common law, and, further, pursuant to ARS Sections 33-271 to 33-276, Grantors do hereby convey to The Nature Conservancy, a District of Columbia non-profit corporation with offices at 1815 North Lynn Street, Arlington, Virginia 22209, its successors and assigns, a conservation easement consisting of the rights and restrictions hereinafter enumerated, on, over and across Grantors' Land.

A. Purposes. It is the purpose of this Conservation Easement to preserve and protect in perpetuity and to enhance and restore the significant relatively natural features and open space values of Grantors' Land. Specifically, and without limitation of the general purposes, it is the purpose hereof to preserve, protect and enhance the open space and natural features on Grantors' Land and the adjoining Bingham Cienega Nature Preserve. In so doing, it is the purpose of this Conservation Easement to permit the continuation on Grantors' Land of such residential and other uses set forth herein as are consistent with the conservation purposes of this Conservation Easement.

B. Rights Granted. The rights conveyed by the Conservation Easement are the following:

1. To identify, preserve and protect in perpetuity, and to enhance by mutual agreement, the ecological features and the native flora and fauna on the Grantors' Land.

2. To enter upon the Grantors' Land to enforce the rights herein granted, to study and make scientific observations of its ecosystems, and to determine that the uses made of Grantors' Land by Grantors are in compliance with the terms of this easement, all upon prior notice to Grantors, and in a manner that does not unreasonably interfere with the use being made of Grantors' Land, consistent with this Conservation Easement, at the time of such entry. The Conservancy shall also have the right of immediate entry to Grantor's Land if, in its sole judgment, such entry is

JLK

necessary to prevent damage to or the destruction of the conservation values protected by this easement.

3. To enjoin any activity on, or use of, the Grantors' Land which is inconsistent with the conservation purposes of this easement, and to enforce the restoration of such features of the Grantors' Land as may be damaged by such activities.

C. Reserved Rights. The following uses and practices on Grantors' Land, though not an exhaustive recital of consistent uses and practices, are consistent with this Conservation Easement, and these practices shall not be precluded, prevented or limited by this Conservation Easement, except for the requirement of the Conservancy's prior consent, as provided herein:

1. To maintain, repair and in the event of their destruction, to reconstruct the existing residential structures and associated outbuildings that are described in the Easement Documentation Report, which is attached to this Conservation Easement as Exhibit 2 and made part hereof by this reference.

2. To construct, maintain, repair and in the event of their destruction, to reconstruct a double carport, equipment shed and single-story, attached additions to the two existing residences and provided each attached addition does not exceed the size of the existing residence.

3. To construct, maintain and repair utilities as are necessary in connection with the residential and agricultural use of Grantors' Land permitted herein.

4. To build, maintain and repair perimeter and interior boundary fences.

5. To maintain and repair the existing vehicleways.

6. To institute and carry on any agricultural activity provided that such activities are limited to the maintenance of a domestic garden and orchard and farming those portions of Grantor's Land presently utilized for grain and livestock feed production as more particularly described in the Easement Documentation Report.

7. To graze domestic livestock.

8. To use biocides and fertilizers only for residential landscape purposes, native revegetation, agricultural purposes and control of noxious weeds and insect pests and only in those

amounts and with that frequency of application which constitutes the absolute minimum necessary to accomplish those purposes; provided that no aerial applications of agrichemicals shall be permitted, and that all agrichemicals shall be used in strict accordance with label directions and restrictions.

9. To cut and remove vegetation within 50 feet of existing residences and outbuildings and to maintain existing pasture.

Pursuant to the terms of ARS Sections 33-271 to 33-276, the Grantors' Land preserved hereby as natural land may not be converted or directed to any uses other than those provided herein.

D. Prohibited Uses. Grantors state that the following uses and practices on Grantors' Land, though not an exhaustive recital of inconsistent uses and practices, are inconsistent with the purposes of this Conservation Easement, and shall be prohibited:

1. Construction or placing of any buildings, camping accommodations, mobile homes, billboards or other structures except the double carport, equipment shed, attached additions, and perimeter and interior boundary fences permitted herein.
2. The division, subdivision or de facto subdivision of the property.
3. Building of new roads, vehicleways or trails, with the exception of a new driveway from house to county road.
4. The operation of any mechanized vehicle off permitted roads/trailways.
5. Dumping of refuse, human foods, garbage or other unsightly offensive or toxic materials including, without limitation, livestock carrion.
6. The storage or use of biocides and chemical fertilizers except as permitted herein.
7. Removal or destruction of any native vegetation, whether dead or alive, except deadwood which poses safety hazard and a provided for herein.
8. The introduction of non-native plant or animal species, except as provided for herein.

J. L. K.

9. Manipulation or alteration of natural water courses, stream banks and associated flood terraces, and any activity which would pollute or degrade any surface or subsurface waters.

10. The exploration or extraction of minerals, hydrocarbons, soils, sand, gravel, rock or other materials on or below the surface of the Grantors' Land.

11. The establishment of any commercial or industrial uses.

12. The installation of utility structures or lines upon or within Grantors' Land, except those provided for herein.

13. Changing of the topography through the placing on the Grantors' land of soil, dredging spoils, landfill and other materials.

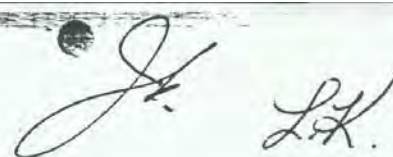
14. Transfer of any water right off the property.

15. Pumping of groundwater for other than on-site domestic and agricultural uses; permitted uses include the restoration of native vegetation.

E. Remedies. Should Grantors, the heirs, successors or assigns of Grantors, undertake any activity requiring approval of the Conservancy without or in advance of securing said approval, or undertake any activity in violation of the terms of this Conservation Easement, then the Conservancy shall have the right to compel the restoration of that portion of the Grantors' Land affected by such activity to the condition that existed prior to the undertaking of such unauthorized activity. In such case, the cost of such restoration and the Conservancy's cost of suit, including attorney's fees, shall be borne by Grantors or those of their heirs, successors or assigns against whom a judgment is entered, or, in the event that the Conservancy secures redress without a completed judicial proceeding, by Grantors or those of their heirs, successors or assigns who are otherwise determined to be responsible for the unauthorized activity. Nothing herein contained shall be construed to preclude Grantors from exhausting their legal remedies in determining whether a proposed activity to which the Conservancy has objected is consistent with the Conservation Easement.

Enforcement of the terms and provisions of this Conservation Easement shall be at the discretion of the Conservancy and any forbearance on behalf of the Conservancy to exercise its rights hereunder in the event of any breach hereof by Grantors, their heirs, personal representatives or assigns, shall not be deemed or construed to be a waiver of the Conservancy's rights hereunder

in the event of any subsequent breach.



F. Taxes and Costs. Grantors agree to pay any and all real property taxes and assessments levied by competent authority on Grantors' Land including any tax or assessment on the easement herein granted, and to bear all costs of their use, upkeep and maintenance of the Grantors' Land, and do hereby indemnify the Conservancy therefrom.

G. Access. Nothing herein contained shall be construed as affording the public access to any portion of the land subject to this Conservation Easement.

H. Assignment. The parties hereto covenant and agree that the Conservancy may assign or otherwise transfer its interest in this Conservation Easement, provided that (1) the Conservancy requires, as a condition of any transfer, that the conservation purposes of this easement continue to be carried out; and (2) any assignment shall be made only to an organization qualified at the time of transfer as an eligible donee under Internal Revenue Code Section 170 (h) (3), or its successor, or any regulations issued thereunder.

I. Changed Circumstances. It is the unequivocal intention of the parties that the conservation purposes of this easement shall be carried out in perpetuity. The Conservancy hereby covenants and agrees that in the event that a later unexpected change in the conditions of or surrounding the Grantors' Land makes impossible or impractical any continued use of the Grantors' Land for the conservation purposes described herein, and the restrictions are extinguished by judicial proceeding, then, upon subsequent sale, exchange or condemnation of the Grantors' Land, the Conservancy will apply its share of any proceeds received from such sale, exchange or taking in a manner consistent with the conservation purposes of this easement, or for the protection of a "relatively natural habitat of fish, wildlife or plants or similar ecosystem," as that phrase is used in P.L. 96 - 541, 26 U.S.C. 170 (1)(4)(a)(ii), as amended, and in regulations promulgated thereunder. The understanding and agreement of the Grantors and the Conservancy regarding their respective rights and obligations under the foregoing circumstances has been reduced to writing, and a copy of such agreement may be obtained, for any legitimate purpose, upon written request directed to The Nature Conservancy at its principal office, 1800 North Kent Street, Arlington, Virginia 22209. In the event of any sale, exchange, devise, or gift of any property subject to this Conservation Easement, Grantors

J.P.H.

agree to furnish a copy of such agreement to the party who acquires the property.

J. Easement Documentation Report. The parties hereto acknowledge that an Easement Documentation Report, attached hereto as Exhibit 2, has been completed by a competent biologist familiar with the environs. The parties have reviewed the Report and acknowledge that it is an accurate description of the physical and biological condition of Grantors' Land at the time of this grant. In the event a controversy arises with respect to the nature and extent of the biological and/or physical condition of the property, the parties shall not be foreclosed from utilizing all other relevant or material documents, surveys, reports, and other information to assist in the resolution of that controversy.

K. Covenant. The terms of this Conservation Easement shall run with and burden title to the Grantors' Land in perpetuity, and shall bind the Grantors, their heirs, successors, personal representatives and assigns.

L. Definition. Except where otherwise expressly stated, the terms "Grantors" and "Conservancy" as used herein, shall be deemed to include, respectively, the Grantors, and the heirs, successors, personal representatives and assigns of each of them, and the Conservancy, its successors and assigns.

M. Severability. If any provision of this deed of Conservation Easement or the application thereof to any person or circumstance is found to be invalid, the remainder of the provisions of the deed of Conservation Easement and the application of such provisions to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

JR. LK

IN WITNESS WHEREOF, the Grantors have hereunto set their hand this 16th day of May, 1988.

Jack Kelly
Jack Kelly

Lois Bingham Kelly
Lois Bingham Kelly

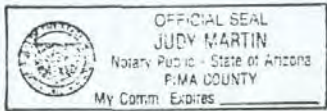
STATE OF ARIZONA This instrument was acknowledged before me this 16th day of May, 1989.

County of PIMA, 19 , by

Jack Kelly and Lois Bingham Kelly

Judy Martin
Notary Public

My Expiration Date is: 12-10-92



~~8538 2503~~

8619 87

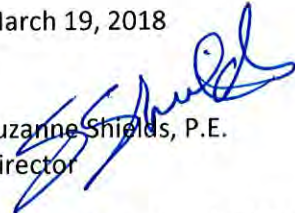
**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 3

USFWS letter regarding Gila topminnow in Santa Cruz River

DATE: March 19, 2018

TO: C. H. Huckelberry
County Administrator

FROM: Suzanne Shields, P.E.
Director 

SUBJECT: Santa Cruz River – Section 10 Permit and the Multi-Species Conservation Plan for Gila Topminnow

The Regional Flood Control District (District) met with the U.S. Fish and Wildlife Service (USFWS) on March 14, 2018 to review the necessary steps for compliance with the Endangered Species Act given the presence of Gila Topminnow in the Santa Cruz River. At the meeting, Scott Richardson, Supervisory Fish & Wildlife Biologist, was in agreement with our position that our Section 10 permit covers the proposed El Corazón project as well as any other activities Pima County and the District may take along the effluent dominated portion of the Santa Cruz River (see attached letter sent to USFWS on March 9, 2018).

We received the attached email from Scott Richardson to the US Army Corps of Engineers confirming that the Biological and Conference Opinion covers El Corazón as well as any other project.

SS/tj

Attachments

c: Carmine DeBonis, Deputy County Administrator – Public Works
Linda Mayro, Director – Office of Sustainability and Conservation
Julia Fonseca, Environmental Planning Manager – Office of Sustainability and Conservation
Eric Shepp, P.E., Deputy Director – Regional Flood Control District
Andy Dinauer, P.E., Division Manager – Regional Flood Control District



March 6, 2018

Mr. Scott Richardson, Supervisory Fish & Wildlife Biologist
U. S. Fish and Wildlife Service
201 N. Bonita Avenue, Suite 141
Tucson, Arizona 85745

Subject: Topminnow in Santa Cruz River Outside the Priority Conservation Area (PCA)

Dear Mr. Richardson:

This letter advises you of a Changed Circumstance as defined under our Section 10(a)(1)(B) Incidental Take Permit # TE-84356A-0 (permit) relative to new populations of listed species detected over the life of the Permit. We are also seeking clarification regarding this Changed Circumstance, as questions have arisen regarding the scope of the Incidental Take Permit's coverage for activities that may impact areas where these new populations have been detected but that fall outside the Priority Conservation Area (PCA) for the listed species.

Pima County has spent hundreds of millions of dollars to improve water quality and wetland conditions in the Santa Cruz River, a finding that has been well documented by the Living River project. A consequence of these improved conditions has been an increase in fish diversity and species richness in the river, which opened the possibility of a listed species to occupy this new habitat. Sure enough, on November 9, 2017, Gila topminnow were recorded at one site on the effluent-dominated stretches of the river downstream of Tucson. The Gila topminnow is one of 44 covered species under Pima County's permit.

Unless genetic tests indicate otherwise, we assume that the topminnow naturally colonized the river. This type of expansion of a covered species' range was explicitly mentioned in the Biological Conference Opinion on page 66, and is considered a "Changed Circumstance" under the terms the permit (see "Population change" section in Table 7.1 of the Multi-species Conservation Plan [MSCP]). This is a favorable outcome of the County's considerable investment in improved waste treatment facilities for which no additional conservation measures are required. As required under the permit, we are hereby notifying you of this Changed Circumstance as defined in our permit and the annual report we submitted to you on March 1, 2018.

In light of this Changed Circumstance, a question has arisen regarding Covered Activities that may impact these new populations of Gila topminnow. The Pima County Regional Flood Control District (RFCD) is planning a critical bank protection project in the Santa Cruz River, where these new populations have been found. This activity is explicitly covered under our permit, and it is located outside of the PCA for the species. As agreed upon in the permit, incidental take is based on acreage within the PCA. Because no area of the Santa Cruz River is located within the PCA of the topminnow, it is our understanding that any incidental take anticipated for this Covered Activity relative to the threshold for reinitiating consultation on this species is zero.

Suzanne Shields, P.E., Director

201 N. Stone Avenue, 9th Floor, Tucson, Arizona 85701-1207 • Phone: 520-724-4600 • Fax: 520-724-4621

Mr. Scott Richardson, U. S. Fish and Wildlife Service

Topminnow in Santa Cruz River Outside the Priority Conservation Area (PCA)

March 9, 2018

Page 2

Enclosed is a copy of a July 3, 2017 letter from Steve Spangle (USFWS Field Supervisor) to Suzanne Shields (RFCD Director) regarding ground disturbance activities by RFCD in the Santa Cruz River. The letter concludes that "there are no additional regulatory requirements (pertaining to covered species) for the District for these activities. Our only request is to be notified if potential effects to covered species from proposed work could be reduced through salvage and relocation."

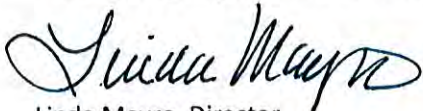
With this direction in mind, Pima County RFCD notified the Corps in January 2018 of these activities. However, some uncertainty was expressed regarding whether the take statement in the Biological Conference Opinion (BCO) is adequate to cover take resulting from these Covered Activities. This confusing response has already caused us to delay a necessary bank-protection project along the Santa Cruz River, one of many Covered Activities identified along the river in the MSCP. We need clarification as quickly as possible on this point so that RFCD can move forward on its critical project, and we can avoid future confusion over similar circumstances that may arise over the life of the permit.

We look forward to our meeting with you on March 15 where we hope these questions can be resolved. The MSCP has been an important step forwarded for the County's development activities and conservation actions, and we have confidence that the USFWS will move quickly to clarify this situation and allow our activities to move forward.

Sincerely,



Suzanne Shields, P. E., Director
Pima County Regional Flood Control District



Linda Mayro, Director
Office of Sustainability and Conservation

SS/LM/tj

Enclosure



United States Department of the Interior

Fish and Wildlife Service
Arizona Ecological Services Office
9828 North 31st Avenue
Phoenix, Arizona 85051



Telephone: (602) 242-0210 Fax: (602) 242-2513

In Reply Refer to:
AESO/SE
22410-2006-F-0459

July 3, 2017

Suzanne Shields, Director
Pima County Regional Flood Control District
201 N. Stone Avenue, 9th Floor
Tucson, Arizona 85701

RE: Clarification of compliance requirements for Pima County Flood Control District Projects under Pima County's Multi-species Conservation Plan

Dear Ms. Shields:

During a meeting with members of Pima County's Office of Sustainability and Conservation and others on June 22, 2017, we became aware of potential concerns the Pima County Regional Flood Control District (District) may have with future conservation actions undertaken through the implementation of Pima County's Multi-species Conservation Plan (MSCP). Concerns your office may have could include a perceived need for additional environmental compliance for temporary and permanent water diversions and bank protection work along the river in reaches where covered species (species identified in the MSCP, both listed and non-listed) are reintroduced or naturally migrate.

Any "take" of covered species associated with these activities, or any other covered activity undertaken by the District, falls under the umbrella of Pima County's Section 10(a)(1)(B) of the Endangered Species Act of 1973 (16 U.S.C. § 1531-1544), as amended, through the implementation of the MSCP. Section 4.8 of the MSCP entitled "Conservation and Recovery of Aquatic and Riparian Species," describes how various conservation activities or strategies are considered in the MSCP. In short, there are no additional regulatory requirements (pertaining to covered species) for the District for these activities. Our only request is to be notified if potential effects to covered species from proposed work could be reduced through salvage and relocation, or the temporary holding of animals (see Section 4.8 of MSCP).

We consider the MSCP to be a model for modern-day conservation of wildlife and habitat and are fortunate to have Pima County as an active partner in achieving our mutual goals for preserving the unique biodiversity of southern Arizona. The overall objective of the MSCP is to outline consistent measures to address endangered species compliance while providing certainty for Pima County with regard to required actions and mitigation. The "no surprises" benefit of

Ms. Suzanne Shields

2

the MSCP is that no additional actions, including mitigation, are required if the MSCP is being properly implemented. Should you have any further questions or require additional clarification, please contact Jeff Servoss of staff (520) 670-6150 (x231) or acting Assistant Field Supervisor, Scott Richardson (520) 670-6150 (x242).

Sincerely,

A handwritten signature in black ink, appearing to read "Steven L. Spangle", with a horizontal line extending to the right.

Steven L. Spangle
Field Supervisor

cc (hard copy):

Field Supervisor, Fish & Wildlife Service, Phoenix, AZ (2 copies)
Assistant Field Supervisor, Fish & Wildlife Service, Tucson, AZ

cc (electronic):

Julia Fonseca, Environmental Planning Manager, Pima County Office of Sustainability and
Conservation, 201 N. Stone, 6th floor; Tucson, AZ 85701
Fish & Wildlife Service, Tucson, AZ (Jeff Servoss, Doug Duncan)

Filename: Letter to Flood Control District (06-2017).docx.js

Tammy Jorde

From: Richardson, Scott <scott_richardson@fws.gov>
Sent: Friday, March 16, 2018 12:38 PM
To: Grove, Kevin W SPL; Julia Fonseca; Brian Powell; Mike Cabrera; Suzanne Shields
Cc: Duncan, Doug
Subject: Pima County MSCP Coverage for the El Corazon project

This message and sender come from outside Pima County. If you did not expect this message, proceed with caution. Verify the sender's identity before performing any action, such as clicking on a link or opening an attachment.

Hi Kevin,

As you know, the USFWS has been discussing and evaluating the way to cover Endangered Species Act coverage for Pima County's El Corazon project, as well as future projects along the Santa Cruz River, as a result of the recent appearance of Gila topminnow in the river (see email below).

After all our review and discussion, the USFWS is confident that the MSCP and associated incidental take permit cover the proposed action of the El Corazon project and other County projects along the Santa Cruz River. There is no need for a separate section 7 consultation. The existing Biological and Conference Opinion covers this proposed action as a covered activity and adequately addresses effects and anticipated take. The ACOE and the County just need to follow the process outlined in the MSCP, the BCO, and our supplemental materials (the flow chart) and discussions we, the ACOE, and the County have had related to these issues and the BCO.

Please do not hesitate to call me if you have any questions or need clarification on anything. Thank you for your support and assistance as we work through implementation of the MSCP and associated permits.

Thanks,
Scott

Scott Richardson
U.S. Fish and Wildlife Service
Tucson Suboffice
(520) 670-6150 x 242

From: Mike Cabrera
Sent: Friday, February 9, 2018 2:14 PM
To: Julia Fonseca <Julia.Fonseca@pima.gov>; Brian Powell <Brian.Powell@pima.gov>
Cc: Grove, Kevin W SPL (<Kevin.W.Grove@usace.army.mil>) <Kevin.W.Grove@usace.army.mil>; John Spiker <spikeshouse33@gmail.com>
Subject: El Corazon

Julia,

We are moving forward on the El Corazon project and after our recent meeting, and unexpected limits of the MSCP, we will be required to go through the Sec 7 consultation process for the topminnow. We need to develop minimization efforts and would like to have someone from OCS assist in the process if possible. Who would be the topminnow expert from your Dept that could help us out? This will likely occur for our other SCR maintenance projects as well so hopefully we can come up with a good process for this reach.

Thank You!

Michael Cabrera, CFM

Pima County Flood Control
Permits and Regulatory Compliance Officer
Infrastructure Management Division
[201 N. Stone Ave](#), 7th Floor
Tucson, AZ 85701
(520)724-4600

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 4

**Pima County Capital Improvement Projects (CIP) Completed in
2018**

All CIP Projects Substantially Completed in Calendar Year 2018

<u>CipProjectNo</u>	<u>ProjectName</u>	<u>CompletionDate</u>
CCD.H04ONT	CD - The Ontario Rental Housing Project	05/30/2018
CCD.HR4001	CD - Housing Reinvestment 2004 Authorization	03/06/2018
CCD.N97BSR	CD - Barrios Santa Rosa & Viejo Shade Structures & Bsktball	06/30/2018
CCD.N97MEN	CD - Menlo Park Exercise Stations	01/30/2018
CCD.N97MID	CD - Midvale Park - Oak Tree Drive Lighting	06/30/2018
CFC.5PWFLT	FC - Pantano Wash Ft Lowell Park to Tanque Verde Road	02/28/2018
CFC.5TSR09	FC - Tesoro Nueve Acquisition	08/30/2018
CFM.X220CT	FM - 220 N. Stone, Suite 170	03/09/2018
CFM.XCPTJR	FM - Utility Tunnel Expansion Joint & Transformer Replacemnt	04/30/2018
CFM.XEPLIB	FM - El Pueblo Library Exterior Paint	02/28/2018
CFM.XJCCTR	FM - Juvenile Courts Cooling Towers Replacement	05/30/2018
CFM.XLHTEP	FM - El Presidio Parking Garage Lighting Retrofit	03/26/2018
CFM.XLSBLT	FM - LSB Lighting Retrofit	02/28/2018
CFM.XSCRRR	FM - Superior Courts Restroom Project	01/30/2018
CFM.XSOARF	FM - Sheriff Administration Roof Replacement	06/30/2018
CFS.XHEDMO	FS - Building 12 Demolition & Electric Service Imprvmts	06/30/2018
CMA.19HOLD	BOS - Marana Local Road Repair Projects -19 HOLD Acct	07/01/2018
COV.19HOLD	BOS - Oro ValleyLocal Road Repair Projects -19 HOLD Acct	07/01/2018
CPC.19HOLD	BOS - Pima CountyLocal Road Repair Projects -19 HOLD Acct	07/01/2018
CPR.PMZSPD	PR - Manzanita Splash Pad	07/30/2018
CPR.XJELKS	PR - Historic Jelks House and Stable Restoration	03/30/2018
CSA.19HOLD	BOS - Sahuarita Local Road Repair Projects -19 HOLD Acct	07/01/2018
CST.19HOLD	BOS - South Tucson Local Road Repair Projects -19 HOLD Acct	07/01/2018
CSU.8LABOR	BOS - Sahuarita FY2018 Labor	03/01/2018
CTR.19LRRP	TR - Local Road Repair Projects FY 18/19	05/23/2018
CTR.4CLBUS	TR - Benson Hwy at Columbus Blvd Intersection Improvements	04/30/2018
CTR.4HAWKS	TR - Annual HAWK Installation Program	03/30/2018
CTR.4HRDEV	TR - S. Houghton Rd Capacity & Drainage Improvements	01/22/2018
CTR.4PPP17	TR - Pavement Preservation Program FY 2017	02/28/2018
CTR.4TRMAR	TR - Tangerine Road: I-10 to La Canada Dr	06/30/2018
CTR.4TTCLV	TR - Thornydale Rd Cortaro Farms Rd to Linda Vista Blvd	03/30/2018
CTU.19HOLD	BOS - City of Tucson Local Road Repair Projects-19 HOLD Acct	07/01/2018
CWW.3AP619	WW - Avra Valley WRF - Pond 6	11/05/2018
CWW.3CTCCB	WW - Corona de Tucson WRD - Chlorine Contact Basin Expansion	11/01/2018
CWW.3ELF19	WW - Tres Rios WRF - Bldg 9, Expand Laboratory Floor Space	10/31/2018
CWW.3GRS18	WW - Green Valley WRF - Grit Removal System Replacement & Up	06/30/2018
CWW.3GVB17	WW - Green Valley WRF - Biofilter Rehabilitation & Upgrade	11/05/2018
CWW.3GVC18	WW - Green Valley WRF - Two Additional Secondary Clarifiers	11/01/2018
CWW.3GVCCO	WW - Green Valley WRF - Disk Filter Cover & Crane	06/30/2018
CWW.3GVE14	WW - Green Valley WRF - Future Development Plan FY13/14	07/30/2018
CWW.3ICB15	WW - 2 Additional Centrifuge Sludge Screens - Tres Rios WRF	06/30/2018

CWW.3SCP06	WW - Sabino Creek Pump Station	08/30/2018
CWW.3SEI13	WW - SE Interceptor Augmentation	07/30/2018
CWW.3SHT16	WW - Tres Rios Sludge Holding Tank	10/30/2018
CWW.3TFM13	WW - Tangerine Rd Force Main Relocation	03/30/2018
CWW.3TRB15	WW - Tres Rios WRF - Blower Modifications	11/01/2018
CWW.3TRP18	WW - System-wide Rehabilitation Program (Replaces 3TRI16)	07/30/2018

CIP Ground Disturbing Projects Substantially Completed in Calendar Year 2018

<u>CipProjectNo</u>	<u>ProjectName</u>	<u>Acres</u>
CCD.H04ONT	The Ontario Rental Housing Project	0.51
CCD.N97BSR	Barrios Santa Rosa/ Cosme Basketball Ct and Shade Canopies	0.83
CCD.N97MEN	Menlo Park Exercise Stations	0.81
CCD.N97MID	Midvale Park - Oak Tree Drive Lighting	6.34
CFC.5PWFLT	Pantano Wash Ft Lowell Park to Tanque Verde Road	9.93
CFM.XHEDMO	Building 12 Demolition & Electrical Service Improvements	0.34
CPR.PMZSPD	Manzanita Park Splash Pad	0.05
CPR.XJELKS	Historic Jelks House and Stable Restoration	1.03
CTR.4CLBUS	Benson Hwy and Columbus Blvd Improvements	9.17
CTR.4TRMAR	Tangerine Road: I-10 to La Canada	180.11
CTR.4TTCLV	Thornydale Rd Cortaro Farms Rd to Linda Vista Blvd	41.85
CWW.3AP619	Avra Valley WRF - Pond 6	14.02
CWW.3CTCCB	Corona de Tucson WRD - Chlorine Contact Basin Expansion	1.04
CWW.3ELF19	Tres Rios WRF - Building 9 - Expand Laboratory Floor Space	0.26
CWW.3GRS18	Green Valley WRF- Grit Removal System Replacement /Upgrade	0.04
CWW.3GVB17	Green Valley WRF - Bio-Filter	0.15
CWW.3GVC18	Green Valley WRF - Two Additional Secondary Clarifiers	0.92
CWW.3NRI14	North Rillito Interceptor Rehabilitation	35.21
CWW.3SCP06	Sabino Creek Pump Station	2.39
CWW.3SEI13	Southeast Interceptor (SEI) Augmentation	5.05
CWW.3SHT16	Tres Rios Sludge Holding Tank	2.22
CWW.3TFM13	Tangerine Road Force Main Modifications - Dove Mountain Blvd. to Camino de Oeste	2.87

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Appendix 5

Gila topminnow as vector control: Green Pool list

Gila topminnow as vector control: Green Pool list

STOCKING DATE	SOURCE OF FISH	STOCKED BY	NUMBER STOCKED	SOURCE OF WATER	CLOSED SYSTEM	DISEASE CERTIFIED	NOTES ON STOCKING SITE
6/8/2017	PCHD	Cynthia Bennett	10	Municipal Water Supply	Yes	Yes	Vacant Home. Topminnow Placed In Pool And Spa. Male and Female Placed in Spa As Well As Pool. Fish Observed Swimming the Area and feeding on larvae. Mosquito Larvae Present. Warrant served to enter property. Homeowner disregarded notices, warrant obtained.
7/12/2017	PCHD	Cynthia Bennett	22	Rainwater	Yes	Yes	Vacant Home. Topminnow Placed In Pool only. No Spa. Mosquito Larvae Present. Fish Observed Swimming the Area and feeding on larvae. Warrant served to enter property. Homeowner disregarded notices, warrant obtained.
9/26/2017	PCHD	Cynthia Bennett	12	Municipal Water Supply	Yes	Yes	Vacant Home. Topminnow placed in pool only. No Spa. Mosquito Larvae Present. Observed Fish swimming area and feeding on larvae. Warrant served to enter property. Homeowner disregarded notices, warrant obtained.
9/26/2017	PCHD	Cynthia Bennett	12	Municipal Water Supply	Yes	Yes	Occupied Home. Homeowner in process of foreclosure and cannot maintain pool. Topminnow placed in pool only. Mosquito Larvae Present. Observed Fish swimming area and feeding on larvae. Warrant served to enter property. Homeowner disregarded notices, warrant obtained.
12/4/2017	PCHD	Gregg Bustamante	20	Municipal Water Supply	Yes	Yes	Occupied Home. Topminnow placed in pool only .No spa. Mosquito Larvae Present. Observed Fish swimming area and feeding on larvae. Warrant served to enter property. Homeowner disregarded notices, warrant obtained.
* 1/4/2018	PCHD	Kathleen Walton	18	Municipal Water Supply	Yes	Yes	Vacant Home. Topminnow Placed In Pool only. No Spa. Mosquito Larvae Present. Fish Observed Swimming the Area and feeding on larvae. Warrant served to enter property. Homeowner disregarded notices, warrant obtained.

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Appendix 6

Parcel list of allocated MSCP mitigation lands

PARCEL NUMBER	NAME	ACRES (GIS)
<i>Bingham Cienega Natural Preserve</i>		
20521002D	BINGHAM CIENEGA	267.81
<i>Cienega Creek Natural Preserve</i>		
30516002A	CIENEGA CREEK NATURAL PRESERVE	37.18
30516002B	CIENEGA CREEK NATURAL PRESERVE	0.37
305122650	CIENEGA CREEK NATURAL PRESERVE	192.05
305122630	CIENEGA CREEK NATURAL PRESERVE	7.25
305110200	CIENEGA CREEK NATURAL PRESERVE	78.17
305122660	CIENEGA CREEK NATURAL PRESERVE	24.39
305122670	CIENEGA CREEK NATURAL PRESERVE	17.66
30511024D	CIENEGA CREEK NATURAL PRESERVE	214.13
30511024D	CIENEGA CREEK NATURAL PRESERVE	47.62
30517006B	CIENEGA CREEK NATURAL PRESERVE	161.14
30517001A	CIENEGA CREEK NATURAL PRESERVE	25.34
30516001C	CIENEGA CREEK NATURAL PRESERVE	12.74
30516001D	CIENEGA CREEK NATURAL PRESERVE	3.49
30516001A	CIENEGA CREEK NATURAL PRESERVE	18.55
30517001B	CIENEGA CREEK NATURAL PRESERVE	68.37
305170020	CIENEGA CREEK NATURAL PRESERVE	147.57
30517001C	CIENEGA CREEK NATURAL PRESERVE	0.91
30604001A	CIENEGA CREEK NATURAL PRESERVE	51.50
30604001A	CIENEGA CREEK NATURAL PRESERVE	0.47
30604001A	CIENEGA CREEK NATURAL PRESERVE	49.60
30517003A	CIENEGA CREEK NATURAL PRESERVE	16.16
30517003B	CIENEGA CREEK NATURAL PRESERVE	6.17
30604001B	CIENEGA CREEK NATURAL PRESERVE	32.87
30604001A	CIENEGA CREEK NATURAL PRESERVE	0.13
30604001B	CIENEGA CREEK NATURAL PRESERVE	0.12
30601021H	CIENEGA CREEK NATURAL PRESERVE	0.50
30601021H	CIENEGA CREEK NATURAL PRESERVE	1.42
305170020	CIENEGA CREEK NATURAL PRESERVE	0.71
30601026E	CIENEGA CREEK NATURAL PRESERVE	10.19
30601026E	CIENEGA CREEK NATURAL PRESERVE	13.74
30518005B	CIENEGA CREEK NATURAL PRESERVE	2.01
30601026E	CIENEGA CREEK NATURAL PRESERVE	0.23
30601021G	CIENEGA CREEK NATURAL PRESERVE	26.41
306050010	CIENEGA CREEK NATURAL PRESERVE	83.68
306050020	CIENEGA CREEK NATURAL PRESERVE	3.17
306050040	CIENEGA CREEK NATURAL PRESERVE	27.13
306080010	CIENEGA CREEK NATURAL PRESERVE	48.32
306090020	CIENEGA CREEK NATURAL PRESERVE	1.12
306090020	CIENEGA CREEK NATURAL PRESERVE	24.55

306090040	CIENEGA CREEK NATURAL PRESERVE	12.39
306080030	CIENEGA CREEK NATURAL PRESERVE	26.66
306080020	CIENEGA CREEK NATURAL PRESERVE	2.73
306090020	CIENEGA CREEK NATURAL PRESERVE	5.51
30609505A	CIENEGA CREEK NATURAL PRESERVE	1.60
306090080	CIENEGA CREEK NATURAL PRESERVE	4.66
30616001B	CIENEGA CREEK NATURAL PRESERVE	11.75
30616001A	CIENEGA CREEK NATURAL PRESERVE	253.30
30618004A	CIENEGA CREEK NATURAL PRESERVE	166.59
30615002A	CIENEGA CREEK NATURAL PRESERVE	75.77
30618504A	CIENEGA CREEK NATURAL PRESERVE	0.02
30588014C	CIENEGA CREEK NATURAL PRESERVE	71.32
306090030	CIENEGA CREEK NATURAL PRESERVE	0.90
30607002A	BAR V RANCH	150.08
30615001A	BAR V RANCH	160.30
306080040	CIENEGA CREEK NATURAL PRESERVE	303.82
306060010	CIENEGA CREEK NATURAL PRESERVE	93.42
305122640	CIENEGA CREEK NATURAL PRESERVE	23.25
30601021J	CIENEGA CREEK NATURAL PRESERVE	897.50
30601026E	CIENEGA CREEK NATURAL PRESERVE	15.15
305122680	FLAP 1227	8.19

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Appendix 7

**Sonoran Desert Tortoise (*Gopherus morafkai*)
Monitoring Protocol**



Pima County Ecological Monitoring Program
Sonoran Desert Tortoise (*Gopherus morafkai*) Monitoring Protocol

January 2019



Prepared by Pima County Office of Sustainability and Conservation Staff:
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Ian W. Murray

Recommended Citation:

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Abstract

The Sonoran desert tortoise (*Gopherus morafkai*) is an iconic species of the Sonoran desert and is a species of conservation concern. Pima County's Multi-species Conservation Plan and Ecological Monitoring Plan define the County's requirement to monitor Sonoran desert tortoise on County conservation lands. County staff designed a long-term occupancy monitoring protocol on three County conservation properties in the Tucson Mountains, balancing concerns of cost-efficiency and travel time with a number of monitoring plots sufficient to generate meaningful results. Field sampling protocols were based on previously implemented occupancy monitoring efforts both on neighboring protected lands and throughout the state (Zylstra et al. 2010) to allow for comparison of monitoring results. Twenty monitoring plots were established in 2018, with subsequent monitoring planned every 2-3 years over the 30-year life of the permit. Overall percent area occupied was estimated at 0.62 (95% CI = 0.53 - 0.72) across all top-ranking models, and overall detection was estimated at 0.64 (95% CI = 0.59 - 0.70) across all sampling periods. The number of available shelter sites and the presence of an incised wash were the most predictive site-level covariates, while observer experience and air temperature were the most predictive survey-level covariates.

Acknowledgements

We would like to thank volunteers D. Turner, S. Mann, and K. Hefty for assistance with occupancy surveys. Mike List provided key GIS expertise and guidance for plot placement. Brian Powell provided important insight and guidance into all parts of planning and implementation of this protocol, as well as substantial amounts of legwork needed during property assessments for tortoise. We also acknowledge the expertise and assistance of Julia Fonseca, Taylor Edwards, Dale Turner, Phil Rosen, and Jeff Servoss, particularly during the project planning phase. We thank NRPR field staff for reporting tortoise observations on County lands. We also thank Pima County's Ecological Monitoring Program Science and Technical Advisory Team members for assistance with program design and protocol review.

Background & Objectives

The Sonoran desert tortoise (*Gopherus morafkai*) is a well-loved, iconic species in Sonoran desert ecosystems. The species is known to occur broadly across much of western and southern Arizona, as well as parts of northwestern Mexico, in upper and lower Sonoran Desert ecosystems. It ranges in elevation from near sea level at the Colorado River to over 1,500 m in southeastern Arizona. Pima County's Sonoran Desert Conservation Plan identified the Sonoran desert tortoise as a species of conservation concern due to its ecological significance. Additionally, the U.S. Fish and Wildlife Service (USFWS) recently decided that federal protections for this species was not warranted (USFWS 2015), in part due to the strong and long-standing commitments that land managers have invested and continue to invest in the study and management of this species. The County's Multi-species Conservation Plan (MSCP) ensures that the County remains in compliance with its Section 10 incidental take permit that it has been issued from the U.S. Fish and Wildlife Service. As part of the MSCP, Pima County has agreed to monitor Sonoran Desert tortoise (hereafter tortoise) populations on County conservation lands.

Pima County's tortoise monitoring objective is to detect biologically meaningful changes in tortoise populations and where possible, to support other monitoring efforts at spatial scales beyond Pima County lands. Pima County staff efforts before monitoring began (2016-2018) focused on improving our understanding of where tortoises occurred across County open space lands. These efforts found that tortoises occur widely across County preserves, including known higher density populations in the Tucson Mountains, Tortolita Mountains, and along the east side of the Santa Catalina Mountains outside of the San Pedro River floodplain (Fig. 1). However, the goals of this monitoring protocol do not simply include inventorying locations where tortoises were observed, but to be able to produce robust and meaningful estimates of tortoise population trends across the 30 year duration of the County's MSCP.

Spatial Sampling Design

Many of these areas require extensive travel time to visit, which thereby limits the amount of time staff can allocate towards implementing the monitoring effort. Additionally, reduced travel time allows for increased number of monitoring plots to be established thereby potentially increasing the power of monitoring results.

After developing a greater understanding of the tradeoffs between area of inference of monitoring results and logistical considerations, Office of Sustainability and Conservation (OSC) staff determined to concentrate surveys at three properties in the Tucson Mountains, 1) the Tucson Mountain Park, 2) Sweetwater Preserve, and 3) Painted Hills Preserve (Fig. 2). These properties are in close proximity to both County offices and metro Tucson, thereby both reducing travel time and allowing for additional questions to be asked such as potentially addressing impacts experienced by tortoise populations that are related to urbanization and encroachment. Importantly, implementing the protocol in a single, easily accessible area allows

for increased probability of change detection over the lifetime of the permit as staff can budget for more plots and site visits as compared to a remote site.

Monitoring Parameter: Occupancy

County staff considered both density and occupancy metrics for the tortoise monitoring protocol. Occupancy is an accepted metric for monitoring wildlife populations, and is less expensive and more time economical as compared to using population density as a monitoring parameter. Occupancy models were developed in the mid-2000s to account for the issue of imperfect detectability, an important issue during wildlife surveys (MacKenzie et al. 2002). Repeated surveys at a series of monitoring plots are used to survey for a species within a specified study area. However, surveys may fail to detect a species, when in fact it is present. The probability of detection of that species on each survey may vary as a function of both landscape level and survey-specific factors, including, vegetation structure, observer experience, and local weather conditions. A site is considered “occupied” when a live animal is observed during that survey. The number and timing of positive detections are then used to estimate the probability of occupancy by site as well as the probability of detecting the species and the overall proportion of area used by the target species within the study area.

Other natural resource managers in Arizona, including the National Park Service and Arizona Game and Fish Department, have in the past, are currently, or are anticipating in the future monitoring desert tortoise using an occupancy-based metric, including in areas nearby Pima County properties in the Tucson Mountains. By following the same protocol, the results of our monitoring effort will be comparable to those of partner agencies.

This document outlines the plot selection criteria and methods, field sampling protocol, and data analysis approach implemented by Pima County staff to monitor Sonoran desert tortoise occupancy on County lands in the Tucson Mountains.

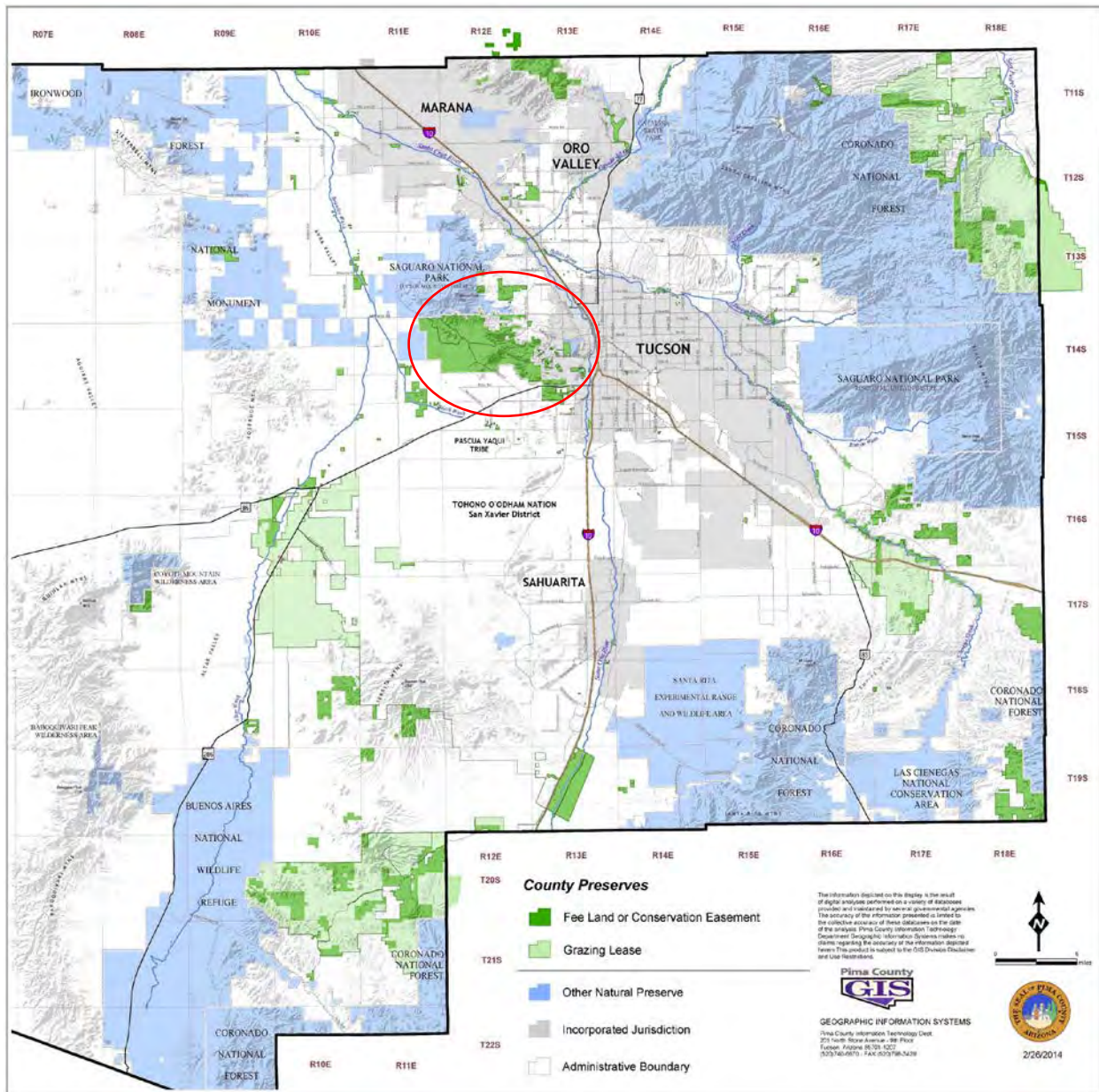


Figure 1. Map of Pima County Conservation Lands (dark and light green), with Tucson Mountain Conservation Properties circled in red.

Monitoring Plot Locations

Plot Generation

We defined plot selection criteria based on prior published recommendations (Zylstra et al. 2010) while incorporating the unique topography, areas of development, and proximity to private property associated with the selected Pima County properties in the Tucson Mountains (Table 1). These criteria included that all plots had to be at least 100 meters from the County property boundary as well as from any roads. Additionally, plots could not be within 50 m of a trail, and were required to be within a one hour hike from the closest access point (i.e., a trailhead or roadside). Occupancy plots also had to be on slopes that were less than 35° and that were within 500 m of a 5° slope. We then utilized the Reversed Randomized Quadrant-Recursive Raster (RRQRR) approach (Theobald et al. 2007) to generate 50 potential monitoring plot locations across the three selected properties that constituted the sampling frame for this monitoring effort (Fig. 2). These plots were spatially balanced, so that if a plot were to be dropped due to severe topography (i.e., not evident in the GIS layer for slope) or a lack of suitable shelter sites (see below) the replacement would still represent the sampling frame as a whole.

Table 1. Sonoran desert tortoise occupancy plot selection criteria.

Criteria	Range/Buffer	Data Source
<i>Slope</i>	<i>< 35° slope, within 500m of > 5° slope</i>	<i>Pima Co. 10ft DEM</i>
<i>Property boundaries</i>	<i>100 m buffer</i>	<i>Pima County Preserves</i>
<i>Roads</i>	<i>100 m buffer</i>	<i>County roads layer</i>
<i>Designated trails</i>	<i>50 m buffer</i>	<i>NRPR TMP Trails layer</i>
<i>Hike time</i>	<i>< 1hr from access points</i>	<i>Calculated – distance from nearest road</i>

Plots were 3 hectare squares, or 170 m on a side (Zylstra et al. 2010). The entire boundary of each plot must have occurred fully within the sampling frame boundary to be included. We selected the first 25 plots locations (20 primary plots with 5 alternates) to be visited during the first round of surveys, with additional alternate plots available if necessary.

Plot Validation

We performed an aerial image and field validation process to identify potential monitoring plots that did not meet sampling criteria. These criteria included the presence of landscape features that were not detected during the initial RRQRR plot generation process, and that would have been grounds for eliminating a plot such as terrain deemed unsafe. Additionally, we removed any plot that had less than two potential tortoise shelters as ascertained by the first field visit (Rubke et al. 2016). We immediately discarded two primary plots and one alternate due to the identification of high social trail density or old livestock watering features during the aerial imagery review. Three alternates were used in place of these discarded plots. Two additional plots were not revisited after the first round of surveys due to containing fewer than

two potential shelter sites. Replacements for these two plots were added and surveyed at the end of the first survey period to maintain consistent sampling effort across all plots (i.e., all plots had one survey in each of three survey periods).

To facilitate ease of field surveys and to ensure adequate survey coverage at each plot, we generated transect lines for each survey plot (Fig. 3). These allowed surveyors to quickly determine whether they were on bearing and maintaining an appropriate distance from other surveyors. Transects were 170 m long, placed 10 m apart, and inset 5 m edges of the plot, for a total of 17 transects per plot. The transects were meant to provide general guidance to ensure that all of each plot was covered, and surveyors were responsible for surveying up to 5 m to either side of each transect. Plots were rotated so that transects ran perpendicular to the prevailing slope for increased safety and efficiency, and were pre-loaded on GPS-enabled field tablets (Panasonic Toughpad FZ-M1 and Garmin Oregon 450).

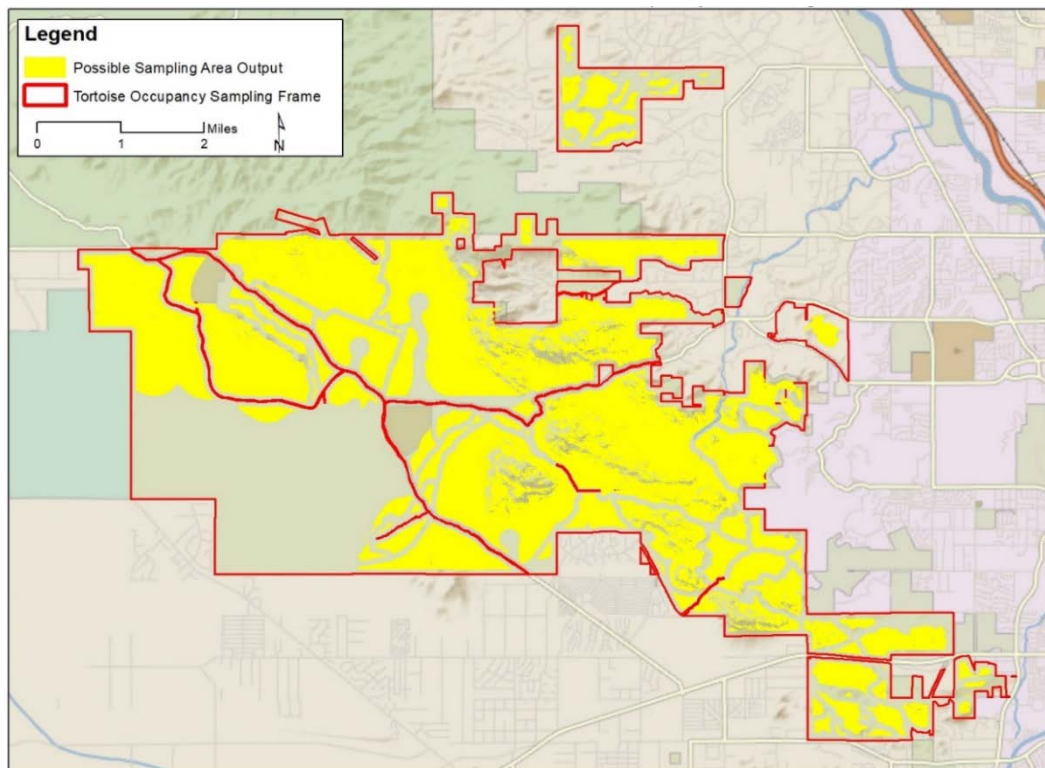


Figure 2. Occupancy monitoring sampling frame in the Tucson Mountains, based on plot selection criteria (Table 1). A large part of the southwestern region of the sampling frame is gently sloping bajada that does not meet the slope criteria.



Figure 3. Example plot boundary (blue) and survey transects (yellow).

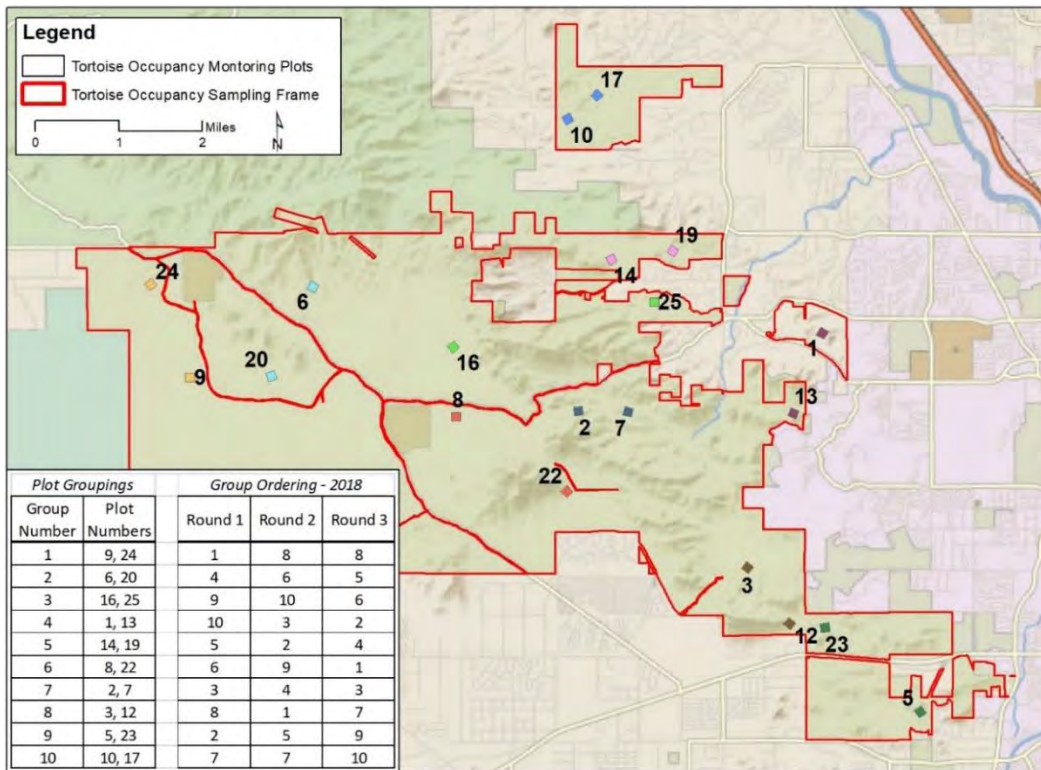


Figure 4. Sampling plot locations, plot groupings are shown in different colors.

Field Sampling Protocol

Field Surveys

We grouped the plots into 10 pairs based on their locations (Fig. 4) to minimize drive/hike time between plots, and increase the likelihood of being able to sample at least two plots per day before temperatures became prohibitively hot. We randomized the order of pairs for each of three sampling periods, and alternated which of the members of a pair we visited first on a given field day (i.e., one plot sampled first during the first survey period, second plot sampled first during the second period). We started surveys between 0600 and 0700 h based on travel time to the plot and length of daylight. Surveyors first navigated to one of the downhill corners of the plot and recorded plot information and starting weather conditions (measured 1 cm above ground in the shade: air temperature, relative humidity, barometric pressure, and cloud cover) using a Kestrel 3500 handheld weather meter (See [Appendix A](#)).

Surveyors generally followed the center line of transects while surveying up to 5 m on either side of the line. The goal was to view the entire plot, accounting for the density of vegetation, the complexity of rock features, or the prevailing slope. This meant that if a plot contained dense vegetation or rough topography, surveyors would walk at a much slower pace compared to plots that had sparser vegetation or more simple topography. Surveyors would veer off the transect line to inspect behind or under vegetation or rock outcrops, as relevant, before returning to the center line to continue onward. If a shelter was observed, the surveyor would inspect it for tortoise sign or presence, which may have required utilizing a flashlight to illuminate deep shelters or an implement to clear packrat midden debris out of the shelter. Transects were typically walked starting at the downhill side of the plot and working uphill. If multiple surveyors were present, transects were walked in parallel with surveyors adjacent to one another and walking in the same direction.

Evidence of tortoise sign or shelter sites were recorded only within the bounds of the plot. (Tortoises or their sign located outside of the plot boundaries were noted as incidental observations, but not included in occupancy analyses.) Recorded sign were carcasses, scat, tracks, and egg shells, while shelter types were caliche caves, dirt burrows, rock shelters, middens, and pallets. A single observation could include both sign and shelter type (i.e. scat inside a rock shelter). The relative age of sign/shelter (< 1 year, > 1 year, or unknown) was also recorded when possible to differentiate current from previous years' sign. Tortoise scats that were < 1 year old were those that were dark in coloration and well formed. We assumed that any rock shelter that could approximately contain an adult tortoise and that was at least one body length deep was a potential tortoise shelter site. Recent tortoise shelters were those that had clear evidence of shaping and scuffing by tortoises, or that contained recent scats or tracks. Lastly, shelters that were unconfirmed as being used by tortoises (i.e., dimensions were such that they were capable of accommodating an adult tortoise, but had no direct evidence of use) were only marked as potential (See [Appendix B](#)).

Tortoise Processing

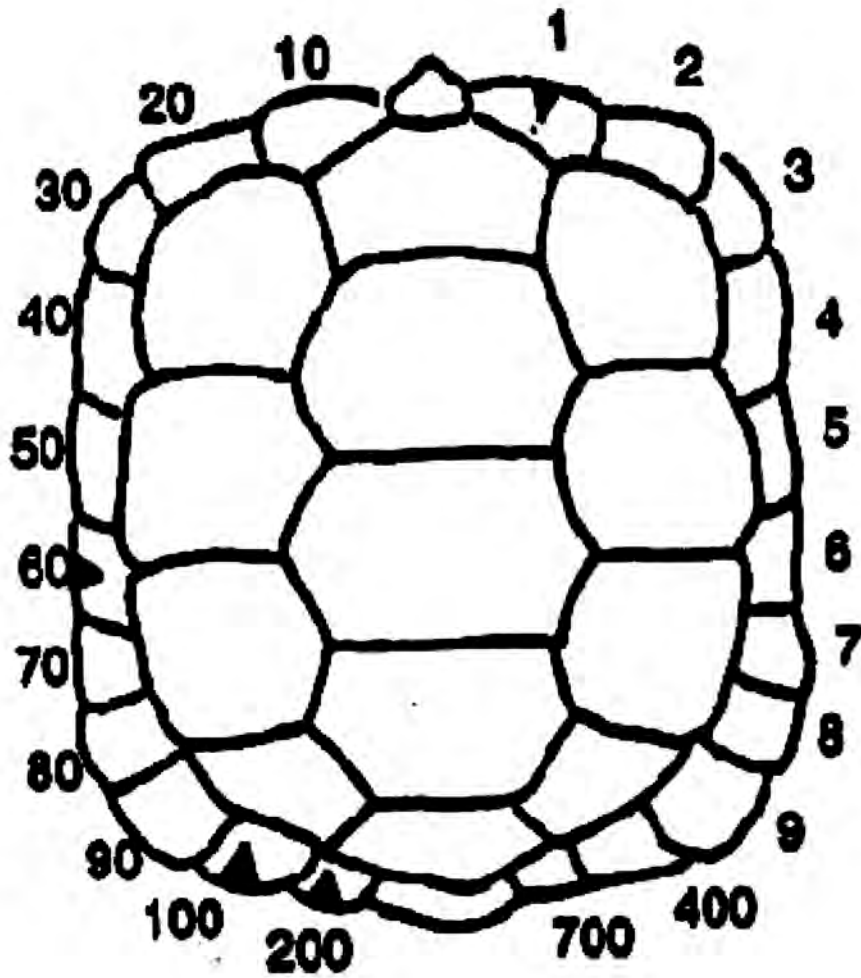
Live tortoises were processed both within the bounds of the plot and within a reasonable proximity of the plot (~200 m; tortoises beyond this distance were not weighed, measured, and marked, but their location noted as an incidental observation). We processed tortoises that were close to, but not on the plots because these individuals could potentially be recaptured on plot during a subsequent plot visit. However, tortoises had to have been found within the boundaries of a plot to be included in subsequent occupancy analyses. Animals were not processed if air temperature exceeded 35°C. Information on environmental conditions, tortoise location and behavior, shelter site, identification, general health, and disease were recorded for each detected individual ([Appendix C](#)).

We permanently marked tortoises in order to track the number of distinct individuals per plot and to gather potential demographic, survival, and movement data if animals were recaptured in subsequent survey periods or years. Animals were marked using a unique ID number (224-290) that was coordinated with AZGFD and Saguaro National Park staff so as not to overlap with known ID numbers for other tortoises that had been marked in the surrounding area (i.e., Saguaro National Park - Tucson Mountain District) during prior monitoring efforts. Individuals were marked with both a “license plate” and marginal scute notches. The “license plate” consisted of applying a small amount of Bic wite-out quick dry correction fluid to the fifth vertebral scute, writing the tortoise’s assigned ID number in permanent marker, and applying fast-drying epoxy with a single use popsicle stick (J-B Weld MinuteWeld Instant-Setting epoxy) to cover and protect the entire area (Fig. 5). Care was taken to not allow epoxy to run across the seams between scutes which could potentially impact the growth of juveniles. Individuals were notched along the marginal scutes using the AZGFD A marking system (Cristina Jones, AZGFD, personal communication; Averill-Murray 2000) and a Nicholson 6” slim taper triangular file (Figs. 5 & 6). Care was taken to make notches deep enough to be permanent but not too deep to cause harm to the tortoise (i.e., notching deep enough to expose bone and cause bleeding). Additionally, bridge scutes (sides of the carapace) were avoided on small individuals as they can potentially cause irreversible damage as animals grow. We did not notch the scutes on very small juveniles (< 100 mm MCL), and for three juveniles < 75 mm MCL, we placed a dab of epoxy-covered wite-out on the 5th vertebral scute without including a number.

We used Pesola scales (5 kg, 2.5 kg, 1 kg, 0.1 kg) to record tortoise mass by using a single use, plastic grocery shopping bag as a sling. We recorded tortoise middle carapace length (MCL) with a 45 cm metal ruler. We made a conscious effort to handle all tortoises with slow and steady movements, keeping them low to the ground (not lifting them high in the air), and did not turn them upside down. We did not handle any animals that we had already marked and processed during previous plot visits, unless the wite-out or permanent marker needed to be touched up. All animals were handled with disposable nitrile gloves; rulers, files, and other equipment that came into contact with a tortoise were all disinfected after each use with a 20% bleach solution to prevent potential disease transmission between individuals.



Figure 5. Marked tortoise with license plate and scute notch shown.



Tortoise number = 361

Figure 6. AZGFD Tortoise Marking System A (Averill-Murray 2000).

Data Analysis

We summarized all sign, shelter sites, and live tortoise observation data by plot and visit number. We used all tortoise detections, both juvenile and adult, in our analyses of occupancy. The number of shelter site observations were averaged across all three sampling periods, by plot, to account for potential differences in detection probabilities and observer experience. We extracted three groups of plot-level covariates used to calculate the probability of occupancy (Ψ): 1) topography, 2) geomorphology, 3) land/vegetation cover (consistent with Zylstra et al 2010). We also extracted covariates associated with each survey date used to calculate probability of detection (p). All covariates are described in detail with units and data sources in Table 2.

We used program PRESENCE (MacKenzie et al. 2017) to analyze desert tortoise occupancy. We followed the three steps for fitting single-season occupancy models with both site-level and detection-level covariates as outlined by MacKenzie (2006) and as followed by Zylstra et al. (2010). Those steps are 1) create models for each covariate group affecting ψ , with all possible combinations of covariates, while keeping a static, basic set of covariates for p , 2) create models for all possible combinations of covariates affecting p , using all covariates represented in top-ranking models from step 1, and 3) create a set of final candidate models with all possible combinations of top-ranking ψ and p covariates derived from steps 1 and 2. In all steps, models were ranked according to their Akaike information criterion (AIC) scores, and only those candidate models with ΔAIC values ≤ 2.0 were included in the final. Model goodness-of-fit was assessed using $c\text{-hat}$ (\hat{c}) (Mackenzie & Bailey 2004). This method uses a parametric bootstrap approach by running 100 iterations of the selected model, calculating the $c\text{-hat}$ test statistic, a measure of overdispersion in the data also called the variance inflation factor. $C\text{-hat}$ values of ~ 1 suggest that the model is appropriate to describe the data (i.e., the data are not overdispersed), where values > 1 suggests that there is a lack of model fit (variance $>$ mean) and that the standard errors of the parameters should be adjusted by the square root of $c\text{-hat}$ (i.e., inflated). A $c\text{-hat}$ of < 1 , or underdispersion, is generally considered acceptable with no need to adjust parameter metrics.

We utilized the integrated model averaging function within program PRESENCE to calculate estimated percent area occupied (in our case likely the percent area used) across the monitoring seasons and detection both by survey period and across all survey periods. Estimates of ψ and p were averaged across all top candidate models (according to model weight) within each monitoring site, and then averaged across all monitoring sites to generate global estimates for percent area occupied and detection (Mackenzie & Bailey 2004). Values were reported with the model estimate and 95% confidence interval. Beta values for all covariates in the top-ranking candidate models were averaged to determine the relative level of influence on predicting either ψ or p .

We then used linear regression to interpret the relationship between individual predictor covariates and either ψ or p .

Results

Field Surveys

We surveyed all 20 monitoring plots three times each during the 2018 monsoon season (July 8 – September 20), with varying lengths of time between successive visits for a given plot (maximum = 45 days, minimum = 13 days, mean = 25 days). We observed live tortoises on 12 of 20 plots (60%) and during 25 of 60 surveys (41.7%). We observed 0-7 live tortoises per survey with an average of 0.783 live tortoises (SE = 0.175) per survey. We observed 49 tortoises (≥ 42 unique individuals) across all surveys, including 11 females, 16 males, and 13 juveniles. Four

tortoises were detected but not marked or processed due to temperatures that we considered too warm to safely extricate them from burrows or rock shelters.

Female and male adult tortoises did not differ in mass or MCL (Fig. 7). Consequently, mean adult mass was 2410 ± 101 g and mean adult MCL was 220 ± 4 mm. On average, juvenile (individuals < 180 mm MCL) mass was 624 ± 131 g and MCL was 126 ± 11 mm. Eight of the 40 tortoises voided during processing (4 males, 1 female, and 1 juvenile). Two adult tortoises, on two different plots had overt symptoms of a respiratory infection including wheezing and/or wet, crackly sounding breathing; however, only one of these individuals had obvious nasal discharge. An additional nine tortoises showed mild swelling of the eyelids (sometimes with inflamed conjunctiva), but these individuals were generally otherwise healthy in appearance with no other evident symptoms of illness. Sixteen individuals had scute or shell anomalies, which primarily consisted of extra or missing marginal scutes; however, several individuals had more extreme anomalies with numerous extra vertebral or costal scutes (Fig. 8).

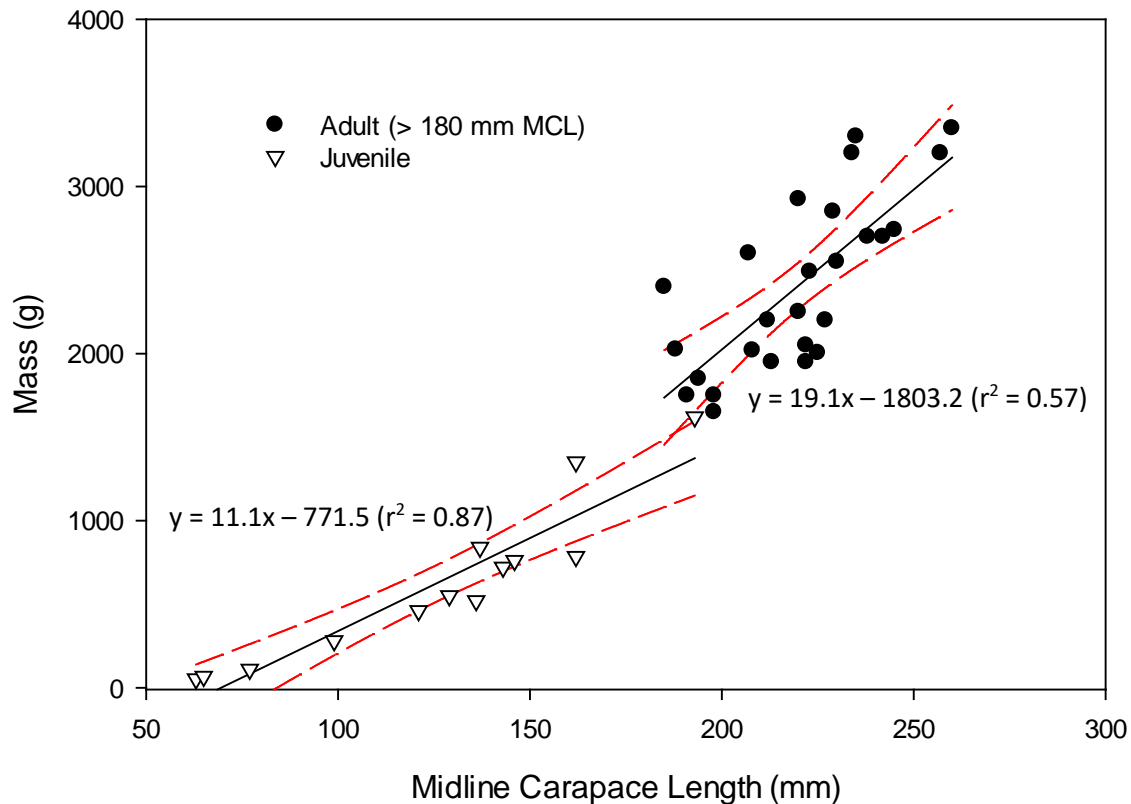


Figure 7. Plotted 95% Confidence intervals on relationship between length and mass for juvenile (< 180 mm MCL) and adult tortoises. Note that we could not sex one individual > 180 mm MCL.



Figure 8. Two tortoises with extreme scute anomalies, including five costal scutes (normally four) and nine vertebral scutes (normally five) on both animals.

Occupancy

Candidate models included covariates from all three tested groups. Top models within the topography group included elevation and slope, and vegetation included average vegetation cover and height; however, all of these individual models had higher AIC values as compared to a model with no defined covariates (i.e., the null model). Top covariates in the geomorphology group were number of available shelter sites and presence of an incised wash; the model with both of these covariates present was the only one to have a lower AIC value than the null model. Observer experience and weather variables (temperature, relative humidity) were the strongest predictors of detection. After assessing the strong correlation between temperature and relative humidity, we decided to use only temperature in final candidate models.

We considered 6 of 33 top-ranking candidate models for analysis (Table 2). Naive occupancy (ψ) for the 2018 monitoring season was 0.6. We estimated overall percent area occupied to be 0.62 (95% CI = 0.53 - 0.72) across all top-ranking models. Goodness of fit for our top-ranking model was acceptable ($\chi^2 = 4.78$, $p = 0.95$), suggesting moderate under-dispersion relative to expected values. The top-ranking model included number of available shelter sites and presence of an incised wash as predictors for occupancy and observer experience and air temperature for detection. Three of the candidate models included one additional parameter (5 versus 4; Table 2) compared to the top-ranking model (i.e., within 2 AIC units of the top-ranking model),

however the negative log likelihood did not appreciably change. This suggests that the additional parameter in these models is an uninformative parameter without ecological basis, and we report them but do not assess the impact from those covariates on either ψ or p (Arnold 2010). The number of potential shelter sites was strongly positively associated with occupancy ($\beta = 3.27$, $SE = 2.45$) and was present in all top-ranking models (Fig. 9). Presence of an incised wash was present in one model and was moderately associated with occupancy ($\beta = 2.04$, $SE = 1.48$), while average percent vegetative cover was also present in one model but minimally associated with occupancy ($\beta = 0.02$, $SE = 0.02$). Additionally, these covariates were only additive to a model with the number of available shelter sites. Lastly, elevation was present in three additional top-ranking models (not shown in Table 2), however all three models failed to converge so these were not included in the final suite of six candidate models. Elevation differed only slightly between plots (775 – 950 m), and is unlikely to have a substantial impact on tortoise occupancy, in this case. All of the evaluated top-ranked candidate models are shown in [Appendix D](#).

Detection (p) decreased slightly as the season progressed, with estimated detection by survey period to be $p_1 = 0.71$, $p_2 = 0.67$, and $p_3 = 0.55$. Overall detection was estimated at 0.64 (95% CI = 0.59 - 0.70) across all three sampling periods. Observer experience was strongly negatively associated with detection ($\beta = -5.67$, $SE = 2.67$, Fig. 10A). This is counterintuitive to the expected result, but this finding may be related to how we estimated surveyor experience, which was calculated as the proportion of surveyors who had had any prior tortoise monitoring experience. In our case, all plots at a minimum, were surveyed by someone with prior experience, and only some surveys included larger teams, some of whom had had no prior tortoise experience. The relationship between numb of observers and detection showed a slight positive relationship (Fig. 10B). Surveyors fatigue throughout the course of the day, and having more surveyors present can allow for more overlap in area surveyed and the potential that another observer might detect any given tortoise. Temperature also slightly positively influenced associated with detection ($\beta = 0.20$, $SE = 0.08$), suggesting that individuals were more visible during hotter periods of the day (Fig. 11). We however suggest that there is a likely a quadratic relationship, where there is an optimal temperature at which tortoises are detectable, however the quadratic relationship did not come out as significant in any of our top models.

Table 2. Top-ranking candidate occupancy model results.

Model	AIC	ΔAIC	AIC weight	Model Likelihood	# Par.	neg2*Log Likelihood
psi(shelter, wash), p(obs, temp)	67.32	0	0.2261	1	4	59.32
psi(shelter, wash, disturb), p(obs, temp)*	68.29	0.97	0.1392	0.6157	5	58.29
psi(shelter, vegcov), p(obs, temp)	68.83	1.51	0.1063	0.47	4	60.83
psi(shelter), p(obs, temp)	69.21	1.89	0.0879	0.3887	3	63.21
psi(shelter, disturb, vegcov), p(obs, temp)*	69.23	1.91	0.087	0.3848	5	59.23
psi(shelter, wash, vegcov), p(obs, temp)*	69.32	2	0.0832	0.3679	5	59.32

* Models were not considered in final parameter estimates due to increased number of parameters but no change in log-likelihood values.

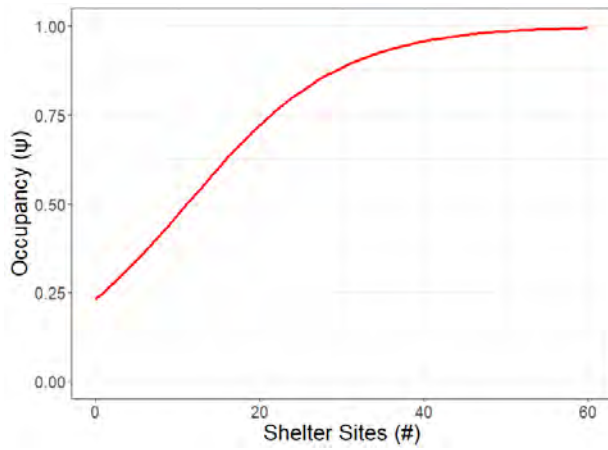


Figure 9. Logistic regression between number of available shelter sites and occupancy.

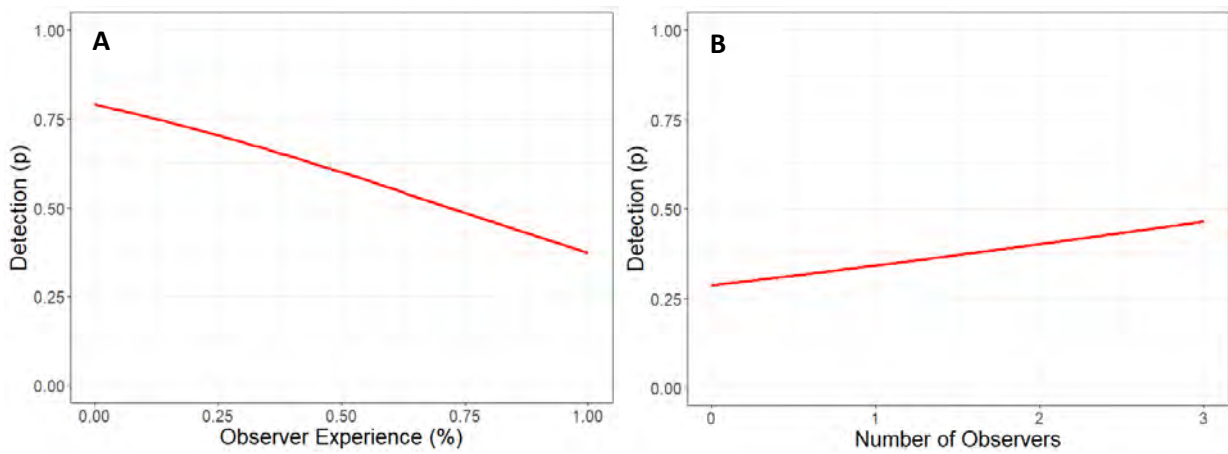


Figure 10. Relationship between A) observer team experience and B) number of observers and detection.

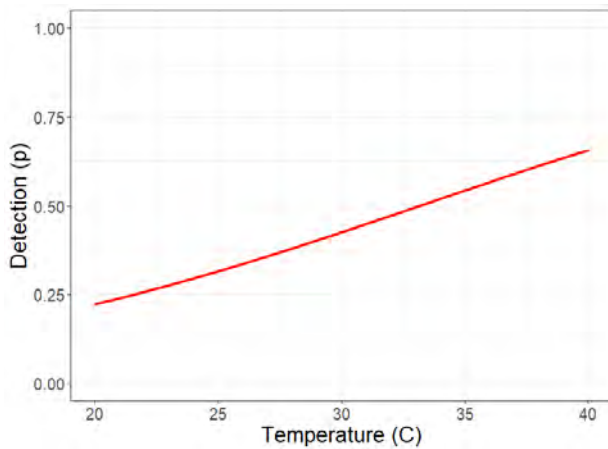


Figure 11. Relationship between survey air temperature and detection.

2018 Monitoring Season Summary

County staff were successful in establishing and monitoring 20 plots in the Tucson Mountains during the 2018 season. Our estimate of occupancy (ψ) was 0.62 (95% CI = 0.53 - 0.72), which is not different from the estimate of 0.72 (95% CI = 0.56 - 0.89) found in a comparable study (Zylstra et al. 2010). However, our overall estimate of detection (p) at 0.64 (95% CI = 0.59 - 0.70) was considerably higher than the estimate of 0.43 (95% CI = 0.33 - 0.52) found in the same study (Zylstra et al. 2010). Estimates from Zylstra et al. 2010 were pooled across all monitoring sites in Saguaro National Park East and West units, potentially allowing for increased estimates of ψ due to incorporation of known high density tortoise populations in the Rincon Mountains. Additionally, that study utilized many more surveyors with varying levels of experience and monitoring sites varied more considerably in landscape position and vegetative structure as compared to our Tucson Mountain sites, potentially allowing for our considerably increased estimate of p . This monitoring effort establishes a baseline for tortoise populations on County lands in the Tucson Mountains and through subsequent monitoring efforts will allow staff to assess, through changes in occupancy, the status of tortoise populations on these properties over time.

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Appendix A: Plot and Weather Information Data Sheet

Pima County EMP - Desert Tortoise Occupancy Monitoring

Plot & Weather Information

GENERAL INFORMATION

Plot Number	Date	Observers	Season Visit Number	Pass
			1	AM
			2	PM
			3	

WEATHER AND PLOT DATA

Start data:

Process Start Time:	Rel Humidity Start:	Temperature (1cm) shaded (C):	Cloud cover Start (%):
			None
			0-25%
			25-50%
			50-75%
			75-100%

End data:

Process End Time:	Rel Humidity End:	Temperature (1cm) shaded (C):	Cloud cover End (%):	Rainfall During Survey?
			None	Yes
			0-25%	No
			25-50%	
			50-75%	
			75-100%	

TORTOISE DETECTION DATA

Live tortoise detected:	Total # live tortoises:	Total tortoise processing time
Yes		
No		

TORTOISE SIGN DATA

Sign detected:	Total # carcasses:	Total # scat:	Total # tracks:
Yes			
No			

SHELTER SITE DATA

Total # caliche caves:	Total # burrows:	Total # middens:	Total # boulder piles:	Total # rock shelter:

OTHER OBSERVATIONS

Recent Human activity?	Photo #s:	total area of buffelgrass (m)
Yes		
No		

Notes: _____

Appendix B: Sign and Shelter Data Sheet

Pima County EMP - Desert Tortoise Occupancy Monitoring Sign & Shelter Observations

GENERAL INFORMATION

Date: _____ Plot Number: _____ Visit Number: _____ Observer: _____

Waypoint	Type of Obs	Sign Type	Shelter Type	Depth inside shelter	Age of sign	Photo #

Sign Type:	Shelter Type:	Age of Sign
Carcass	Caliche cave	<1 year
Carcass piece	Dirt burrow	>1 year
Scat	Rock shelter	
Tracks	Midden	
Egg shells	Pallet	
N/A	N/A	

Appendix C: Plot and Weather Information Data Sheet

Pima County EMP - Desert Tortoise Occupancy Monitoring

Live Tortoise Observation

GENERAL INFORMATION

Date:	Plot Number	Visit Number:	Waypoint Number:	Observer:	Process Start Time:	Process End Time:
-------	-------------	---------------	------------------	-----------	---------------------	-------------------

ENVIRONMENTAL INFORMATION

shaded 1cm air temperature (°C)	relative humidity (%)
---------------------------------	-----------------------

LOCATION AND BEHAVIOR INFORMATION

Tortoise Location	Tortoise Behavior
In open	Resting
Under vegetation	Basking
Palle	Walking
Burrow	Feeding
Rock shelter	Digging
Caliche cave	Asleep

SHELTER SITE INFORMATION

Substrate above:	Substrate below:	Depth inside	Other tortoises
Rock	Rock	<0.5m	Yes
Soil	Soil	0.5-1.0m	No
Caliche	Caliche	>1.0m	
Vegetation	Unknown	Unknown	

TORTOISE IDENTIFICATION INFORMATION

Tortoise ID:	Capture type:	Sex:	MCL (mm):	Weight (g):	Scute anomalies?
	1st capture	M			Yes (notes in comments)
	Recapture	F			No
	Unknown	Unknown			

Notched today?	Expoxied today:	L Posterior Scutes:	R Posterior	L Marginal	R Marginal Scutes:
Yes	Yes	100	400	10	1
No	No	200	700	20	2
Previously done	Previously done			30	3
Touched up	Touched up			40	4
				50	5
				60	6
				70	7
				80	8
				90	9

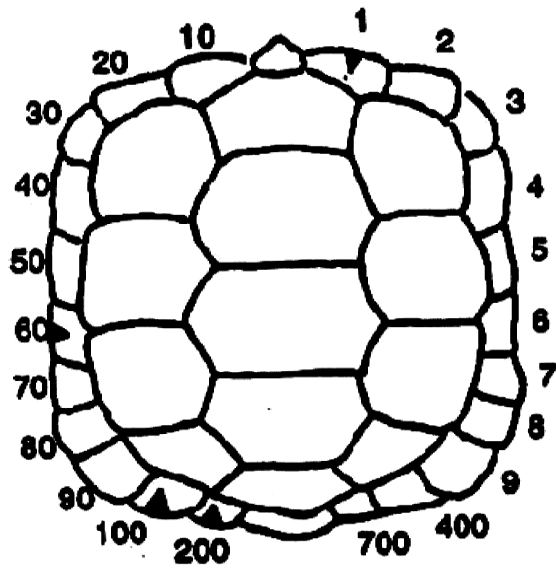
GENERAL HEALTH INFORMATION

Breathing:	Nasal discharge:	Beak/Nares:	Exudate:	Nares Occluded:	Eyes:	Eyelids:
Smooth	Yes	Dry	None	Neither	Bright	Swollen
Wheezing	No	Damp	Clea	Righ	Cloudy	Wet
Rasping/clicking		Wet	Cloudy	Left	Sunken	Discolore
			White	Both		Normal
			Yellow			

Oral	Posture:	Shell closure:	Chin glands:	Integument:	Parasites?	Voided?
Discharge	Alert	Tight	Swollen	Dull	Yes	Yes
Pink	Lethargic	Limp	Draining	Glossy	No	No
White			Normal	Normal		
Plaque				Peeling		
Unknown						
n						
Volume of Void (ml):	During:	Urine				

SHELL/BONE DISEASE INFORMATION
Shell anomalies/irregularities:

Shell anomalies/irregularities:	Shell	Shell pitting:	Shell wear	Scute	Fungus/necrosis	Evidence of trauma (select all)
Yes	None	Yes	1	Yes	Yes	Head
No	Present	No	2	No	No	Forelimbs
	Active		3			Hindlimbs
	Healed		4			Gular
			5			Carapace
			6			Plastron
			7			Bone/scute replacement



Tortoise number = 361

Appendix D: 2018 Occupancy Monitoring Data & Results

Table D1. Site and detection-level covariates used in occupancy analysis

Variable Name	Description	Units	Data Source
Site Variables			
<i>Topography</i>			
Elevation	Elevation of plot center	Meters	3 m Digital Elevation Model
Slope	Average slope - 100 random locations / plot	Degrees	3 m Digital Elevation Model -
Average Aspect	Mean zonal aspect for each plot	Degrees	3 m Digital Elevation Model - CalcZonalMeanAspect (https://community.esri.com/thread/47864)
Percent North Aspect	Percent of plot facing north, 315-45 degrees	Percent	3 m Digital Elevation Model
Percent East Aspect	Percent of plot facing east, 45-135 degrees	Percent	3 m Digital Elevation Model
Percent South Aspect	Percent of plot facing south, 135-225 degrees	Percent	3 m Digital Elevation Model
Topographic Ruggedness Index	Topographic ruggedness index	N/A	3 m Digital Elevation Model – TRI ArcGIS tool (https://www.arcgis.com/home/item.html?id=334346db638844039dc1c4abf5dd8d00)
Precipitation	30-year normal annual precipitation	Millimeters	PRISM Climate Group – 800 m resolution data product
<i>Geomorphology</i>			
No. of Shelter Sites	Number of total possible/confirmed shelters averaged across all visits	Count	Field observation
Soil Type	Dominant soil type: Anklam-Cellar-Rock outcrop complex, 15 to 55 % slope	Presence	NRCS SSURGO
Soil Type	Dominant soil type: Pinaleno-Stagecoach complex, 5 to 16 percent slope	Presence	NRCS SSURGO
Soil Type	Dominant soil type: Pinaleno very cobbly sandy loam, 1 to 8 percent slope	Presence	NRCS SSURGO
Soil Type	Dominant soil type: Pantano-Granolite complex, 5 to 25 percent slope	Presence	NRCS SSURGO

Presence of Incised Wash	Presence of incised wash on plot	Presence	Field observation / aerial imagery
Vegetation			
Avg. Percent Vegetation Cover	Average vegetation percent cover, middle value of each bin was taken per cell (i.e., 10-20% =15%)	Percent cover	Landfire 2014 Existing Vegetation Cover dataset, 30 m resolution
Avg. Vegetation Height	Average vegetation height middle value of each bin was taken per cell (i.e., 1-2 m = 1.5 m)	Meters	Landfire 2014 Existing Vegetation Height dataset, 30 m resolution
Percent Riparian Vegetation	Percent of plot classified as riparian vegetation	Percent	Landfire 2014 Existing Vegetation Type dataset, 30 m resolution
Percent Upland Vegetation	Percent of plot classified as upland vegetation	Percent	Landfire 2014 Existing Vegetation Type dataset, 30 m resolution
Bufflegrass	Number of buffelgrass bunches per plot	Count	Field observation
Distance to Development	Straight-line distance from center of plot to nearest development outside of the Pima County property	Meters	National Land Cover Dataset and Aerial imagery

Detection Variables	
Survey Period	Survey period
Order First	Plot survey completed first during field day (y/n)
Order Second	Plot survey completed second or third during a field day (y/n)
Avg. Relative Humidity	Average relative humidity between start/end of survey (%)
Avg. Temperature	Average temperature between start/end of survey (° C)
Rain During Survey	Rain during survey (y/n)
Avg. Cloud Cover	Average visually estimated cloud cover between start/end of survey, (bins: None, 0-25%, 25-50%, 50-75%, >75%)
Experience Level	Percent of team with experience surveying for desert tortoises (%)

Table D2. Land cover (vegetation) covariates model selection results (percent cover, average height, percent riparian vegetation, distance to development).

Model	AIC	Δ AIC	AIC weight	Model Likelihood	# Par.	neg2*Log Likelihood
psi(cov),p(stand)	77.12	0	0.1685	1	3	71.12
psi(height),p(stand)	77.19	0.07	0.1627	0.9656	3	71.19
psi(develop),p(stand)	77.98	0.86	0.1096	0.6505	3	71.98
psi(riparian),p(stand)	78.3	1.18	0.0934	0.5543	3	72.3
psi(cov,develop),p(stand)	78.47	1.35	0.0858	0.5092	4	70.47
psi(height,develop),p(stand)	78.58	1.46	0.0812	0.4819	4	70.58
psi(cov,height),p(stand)	79.1	1.98	0.0626	0.3716	4	71.1
psi(cov,riparian),p(stand)	79.12	2	0.062	0.3679	4	71.12
psi(riparian,develop),p(stand)	79.81	2.69	0.0439	0.2605	4	71.81
psi(cov,height,develop),p(stand)	80.39	3.27	0.0328	0.195	5	70.39
psi(cov,riparian,develop),p(stand)	80.44	3.32	0.032	0.1901	5	70.44
psi(height,riparian,develop),p(stand)	80.54	3.42	0.0305	0.1809	5	70.54
psi(cov,height,riparian),p(stand)	81.1	3.98	0.023	0.1367	5	71.1
psi(cov,height,riparian,develop),p(stand)	82.38	5.26	0.0121	0.0721	6	70.38

Table D3. Topographical covariates model selection results (elevation, slope, aspect).

Model	AIC	Δ AIC	AIC weight	Model Likelihood	# Par.	neg2*Log Likelihood
psi(elev),p(stand)	77.81	0	0.173	1	3	71.81
psi(slope),p(stand)	77.93	0.12	0.1629	0.9418	3	71.93
psi(aspect-s),p(stand)	78.26	0.45	0.1381	0.7985	3	72.26
psi(elev,aspect-e),p(stand)	79.28	1.47	0.083	0.4795	4	71.28
psi(slope,aspect-s),p(stand)	79.29	1.48	0.0825	0.4771	4	71.29
psi(elev,aspect-s),p(stand)	79.3	1.49	0.0821	0.4747	4	71.3
psi(slope,aspect-e),p(stand)	79.48	1.67	0.0751	0.4339	4	71.48
psi(elev,slope),p(stand)	79.65	1.84	0.0689	0.3985	4	71.65
psi(aspect-e/s),p(stand)	79.69	1.88	0.0676	0.3906	4	71.69
psi(elev,slope,aspect-s),p(stand)2	80.99	3.18	0.0353	0.2039	5	70.99
psi(elev,slope,aspect-e),p(stand)	81.22	3.41	0.0314	0.1818	5	71.22

Table D4. Geomorphological covariates model selection results (# shelter sites, presence of incised wash, soil type).

Model	AIC	Δ AIC	AIC weight	Model Likelihood	# Par.	neg2*Log Likelihood
psi(shelter,wash),p(stand)	73.16	0	0.4509	1	4	65.16
psi(shelter,wash,soil),p(stand)	75.16	2	0.1659	0.3679	5	65.16
psi(shelter),p(stand)	75.46	2.3	0.1428	0.3166	3	69.46
psi(shelter,soil),p(stand)	75.54	2.38	0.1372	0.3042	4	67.54
psi(soil),p(stand)	77.67	4.51	0.0473	0.1049	3	71.67
psi(wash),p(stand)	78.09	4.93	0.0383	0.085	3	72.09
psi(wash,soil),p(stand)	79.64	6.48	0.0177	0.0392	4	71.64

Table D5. Top-ranking candidate models.

Model	AIC	Δ AIC	AIC weight	Model Likelihood	# Par.	neg2*Log Likelihood
*psi(shelter,wash,elev),p(obs,temp)	63.8	0	0.4354	1	5	53.8
*psi(shelter,wash,elev),p(obs,temp)	65.8	2	0.1602	0.3679	6	53.8
*psi(shelter,wash,aspect-s),p(obs,temp)	65.8	2	0.1602	0.3679	6	53.8
psi(shelter,wash),p(obs,temp)	67.32	3.52	0.0749	0.172	4	59.32
psi(shelter,wash,disturb),p(obs,temp)	68.29	4.49	0.0461	0.1059	5	58.29
psi(shelter,vegcov),p(obs,temp)	68.83	5.03	0.0352	0.0809	4	60.83
psi(shelter),p(obs,temp)	69.21	5.41	0.0291	0.0669	3	63.21
psi(shelter,disturb,vegcov),p(obs,temp)	69.23	5.43	0.0288	0.0662	5	59.23
psi(shelter,wash,vegcov),p(obs,temp)	69.32	5.52	0.0276	0.0633	5	59.32
1 group, Constant P	74.46	10.66	0.0021	0.0048	2	70.46
1 group, Survey-specific P	78.21	14.41	0.0003	0.0007	4	70.21

* Models estimates did not converge to significant digits greater than 3, these models were not included in analysis.

**Pima County
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Appendix 8

Sonoran Desert Tortoise Monitoring Rack Card



Desert Tortoise Monitoring Program

The Tucson Mountains are home to a true desert icon: the Sonoran desert tortoise. This remarkable species has been roaming these rocky hills and washes for millennia. Unfortunately, encroaching development and invasive species (especially buffelgrass) are negatively impacting tortoises and their habitat.

To track tortoise populations across County-owned properties in the Tucson Mountains, Pima County recently began a long-term monitoring Program in

support of the County's Multi-species Conservation Plan (see the back of this card for more information). In 2018, County



staff found 44 tortoises and marked each with a white "license plate" number for future identification. Pima County plans to monitor tortoise populations every 2-3 years for 30 years.

**More information about the county's tortoise monitoring program can be found at:
www.pima.gov/DesertTortoise**

If you encounter one of the marked tortoises please know: it is illegal to harass, harm, or collect a desert tortoise. Unless you are helping a tortoise across a road (where it might otherwise be run over by a vehicle), harassment includes handling these animals; doing so might make the animal void (pee), thereby causing it to lose critical fluids that it needs to survive our harsh desert environment. If you see a marked tortoise, enjoy it from a distance of at least 5 feet.

Pima County is committed to the protection of tortoise habitat by purchasing and preserving open space lands and by sponsoring buffelgrass removal efforts. Consider joining one of these events and be a tortoise hero.



Finally, please obey park rules; they are meant sensitive resources. For example, park rules such as prohibiting dogs (Tucson Mountain Park), or requiring dogs to be on a leash (Sweetwater Preserve, Feliz Paseos Park, and Robles Pass Park) help protect tortoises because dog attacks are a leading cause of tortoise injury and death.

Tortoise monitoring is one element of the County's Multi-species Conservation Plan, which provides regulatory coverage to the County and our development community by facilitating compliance with the Endangered Species Act. In exchange for compliance coverage, Pima County must avoid, minimize, or mitigate the impacts of land development activities through the protection, management, and monitoring of lands and species. To learn more about the MSCP, visit www.pima.gov/mscp.



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Multi-species Conservation Plan:
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Appendix 9

**Cactus Ferruginous Pygmy-Owl Monitoring and Habitat
Assessment on Pima County Conservation Lands
Final Report**

Cactus Ferruginous Pygmy-Owl Monitoring and Habitat Assessment on Pima County Conservation Lands

Final Report

Contract No. CT-SUS-17-211

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ABSTRACT

To address obligations linked to the recently approved Pima County Multi-species Conservation Plan, I identified and estimated the quality of habitat for the Cactus Ferruginous Pygmy-Owl (*Glaucidium brasilianum cactorum*; hereafter “pygmy-owls”) and surveyed owls on Pima County Conservation Lands in south-central Arizona in 2017. To identify habitat and prioritize areas for surveys across a vast region of County lands, I used a model of habitat quality developed in neighboring Sonora, Mexico together with aerial reconnaissance for saguaros and remotely-sensed data on woody vegetation cover. I evaluated the existing survey protocol for pygmy-owls recommended by the U.S. Fish and Wildlife Service, developed a more efficient survey protocol, and used this approach to survey owls along 11 transects three times; once shortly before breeding in March, once during nesting in April, and following breeding in October when young owls are dispersing and selecting home ranges. I documented a fairly large population of pygmy-owls in the northern Altar Valley and detected pygmy-owls along 10 of the 11 transects surveyed during at least one season with occupancy and abundance peaking during October when 46% of survey stations were occupied. I located four nests and three likely nests—all in saguaro cacti—that contained an average of 4.5 eggs and were located between 846 and 1,177 m elevation (mean = 1,038 m). In general, pygmy-owls were found to be more common and broadly distributed than previously known in the northern Altar Valley and in southern Arizona in general. In total, I documented 20 distinct territories occupied by territorial male pygmy-owls including 17 territories that were not known before this effort. These new territories roughly doubled the known population of pygmy-owls in the northern Altar and adjacent Avra valleys in Arizona, and increased the total number of historical (i.e., known within the last 20 years) sites in the broader region by 44%. Importantly, I validated the utility of a useful quantitative tool for identifying areas on the landscape to prioritize for surveys, which is broadly applicable for other management and recovery applications for this species. Despite the rarity of pygmy-owls on the landscape, virtually all transects I identified for surveys were occupied by one or more pygmy-owls during one or more survey events. Moreover, observed pygmy-owl distribution was associated with the estimated quality of space in directions predicted by theory as indicated by a positive relationship between persistence in occupancy across the three surveys and the estimated local quality of habitat. In combination with management strategies that preserve and perpetuate the continued existence of habitat, these results confirm the value of Pima County conservation lands for the pygmy-owl. Baseline data collected during this effort and summarized here provide a strong foundation for long-term trend monitoring of pygmy-owls on Pima County conservation lands.

ACKNOWLEDGEMENTS

I thank Brian Powell for assistance coordinating aerial surveys and photos, access to County properties, obtaining research permits, and selecting survey sites. I thank Ian Murray, Iris Rodden, and Don Carter for assisting with pygmy-owl surveys, and Iris Rodden for help with access to various properties, and with nest searches that resulted in her locating one nest in a cactus that I passed up as unoccupied. I thank Chris Jarchow and Pamela Nagler of the U.S. Geological Survey in Tucson for estimating woody vegetation cover with use of Landsat data. Pilot Greg Bedinger and Program Specialist Tara Rowe of [LightHawk](#) enabled us to survey habitat from air, thus greatly advancing the efficiency of this effort. Jeff Gicklhorn, Ian Murray, and Brian Powell provided reviews of this report. Finally, I thank Lynn Frazier and the School of Natural Resources and the Environment for assistance managing this grant.

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INTRODUCTION

Surveying and monitoring populations of rare species across large regions is challenging, especially when resources and baseline data are limited. In southern Arizona, concern for the Cactus Ferruginous Pygmy-Owl (*Glaucidium brasilianum cactorum*; hereafter “pygmy-owls”) helped galvanize regional efforts in conservation planning including the recently approved Pima County Multi-species Conservation Plan (MSCP; Pima County 2016). Pygmy-owls are among 44 species covered under the MSCP, which requires populations on County lands be monitored to assess population trends and distribution. Little is known about the distribution and abundance of pygmy-owls on Pima County’s conservation lands, however, and there are few known historical localities on these lands. Addressing monitoring needs on County conservation lands is further complicated by few recent surveys on these lands, limited resources available for monitoring, and the large spatial extent and location of these lands. To develop an effective monitoring program, advanced tools capable of identifying habitat and quantifying the likelihood of occupancy are needed to focus initial survey efforts.

Information on habitat suitability can inform selection of survey and monitoring sites across large landscapes, even in cases where no prior information exists on distribution and abundance of the focal species. Theoretical models in combination with empirical data indicate that individual animals select the best available habitats first and use these areas more consistently across time because behaviors that promote optimal choices yield higher demographic performance (Fretwell 1970, Sergio and Newton 2003, Flesch 2017). Hence, information on spatial variation in habitat quality can help highlight priority areas on the landscape for surveys, monitoring, and management and recovery activities so that resources are expended efficiently.

To develop an efficient and effective monitoring program for pygmy-owls on Pima County conservation lands, I began by using a model of pygmy-owl habitat quality derived in similar environments in nearby Sonora, Mexico and developed a spatially-explicit approach to identify areas most likely to support pygmy-owls. This model estimated expected reproductive output of pygmy-owls as a function of various territory-specific habitat resources and conditions and was developed using data from observed reproductive output of pygmy-owls from nearly 500 nesting events within 107 territories in Sonora over a 10-year period (Flesch et al. 2015). For the current project, I applied this model in areas with saguaro cacti and in one instance large trees (>10 m tall) on lands managed by Pima County in the Altar and Avra valleys because these structures provide essential nest cavities for pygmy-owls. I then used resulting estimates to select a sample of potential survey areas and surveyed these areas three times between March and October 2017.

Information from this effort are important beyond the areas surveyed because identifying areas not previously known to support pygmy-owls in southern Arizona is useful for understanding the distribution and status of populations and for guiding recovery efforts. Although now removed from the endangered species list for reasons unrelated to recovery (USFWS 2006), populations of pygmy-owls have declined to extirpation in two of the three watershed regions in which they recently occurred in south-central Arizona and there is no recent evidence of occupancy near Tucson (Flesch et al. 2017). Similarly, focused monitoring and research efforts in neighboring northern Sonora indicate marked declines in abundance between 2000 and 2011 but some important increases in these same areas since 2012 (Flesch and Steidl 2006, Flesch 2014, Flesch et al. 2017). Recent modeling efforts suggest these patterns are being driven by drought and extreme weather (possibly linked to climate change), natural variation in habitat quality, urban growth, and interactions among these factors (Flesch 2014, Flesch et al. 2015, 2017). Efforts to conserve populations of pygmy-owls in Arizona promote the long-term success of regional conservation plans such as the Sonoran Desert Conservation Plan, but focused monitoring and research are needed to realize those goals.

This report summarizes results of habitat assessments and surveys for pygmy-owls on Pima County conservation lands in the Altar and Avra valleys west and southwest of Tucson. Specifically, goals of this project were to: 1) identify areas of potential breeding habitat for pygmy-owls on County conservation lands, and estimate the relative quality of that habitat, 2) establish 10 survey transects in areas that support habitat for pygmy-owls, 3) survey points along these transects three times (once during the territorial establishment period, once during the breeding season, and once during the post-breeding dispersal period), 4) describe the distribution, abundance, and breeding status of pygmy-owls observed along survey transects, and 5) provide information to guide future monitoring and conservation of pygmy-owls on County conservation lands. Additionally, to increase the efficiency of the surveys, and with input from USFWS species experts,

I revised the USFWS survey protocol for pygmy-owls (USFWS 2000) based on data from extensive observations of pygmy-owls in Sonora (Flesch and Steidl 2007a).

METHODS

Study Area—In coordination with staff of the Pima County Office of Sustainability and Conservation, I considered areas owned or managed by Pima County in the Altar and Avra valleys (Figure 1). These areas were selected because they are closest to areas with recent, known occupancy by pygmy-owls and thus most likely to support a population. This region includes large County-owned and leased properties: Tucson Mountain Park and Lord's Ranch to the north of AZ State Route 86, and Rancho Seco, Marley Ranch, Diamond Bell Ranch, and Old Hayhook Ranch located south of Route 86. Within these properties I focused on identifying priority survey sites in areas with mature saguaro cacti or large trees capable of providing nesting habitat for pygmy-owls.

Design and Habitat Assessments—To determine survey sites on County conservation lands, I employed a stepwise process. First I mapped the general distribution of saguaro cacti because they provide nest cavities and are a fundamental component of pygmy-owl habitat. Saguaros in this region are uncommon and distributed very patchily in singles or small groups often near rocky outcrops or the upper portion of outwash plains. Given this distribution and because saguaros are difficult to detect and map using remote-sensing tools, project coordinator Brian Powell and I enlisted the services of [LightHawk](#) to fly us over potential habitat in a small plane from which we identified and photographed areas with saguaros (Figure 1). Areas with saguaros were subsequently mapped in Google Earth, which I used together with aerial photographs taken from the plane to estimate the approximate number and location of mature saguaros in and adjacent to County conservation lands. This process identified a sample of 92 patches on the landscape where one or more adult saguaro occurred on or immediately adjacent to County lands, and 6 patches with large trees with cavity potential (>10 m tall), which could support nesting pygmy-owls on County conservation lands within the study area. Second, at each of these locations, I placed a 400-m radius circular plot around a centrally-located saguaro (or large tree) in a way that minimized overlap among plots and maximized coverage of areas with saguaros the landscape. A 400-m radius circular plot (e.g., 50 ha) was used because it is the approximate size of a breeding pygmy-owl home range (Flesch et al. 2015). Finally, within each plot, which represented a potential breeding home range, I used a model developed in adjacent Sonora to estimate the relative quality of habitat based as indexed by predicted reproductive output.

In addition to saguaros, both the quantity and spatial arrangement of woodland vegetation and presence of semi-desert grasslands (vs. desert-scrub) are important drivers of habitat quality for pygmy-owls (Flesch 2014, Flesch et al. 2015). More specifically, the model of habitat quality I used to estimate habitat quality indicates that long-term reproductive output of pygmy-owls is positively associated with increasing abundance of saguaro cacti, moderate to high levels of woody vegetation cover, low levels of woodland fragmentation, and presence of semi-desert grasslands (Flesch 2015). Thus, to apply this model to County lands, I used data on mean woody vegetation cover across each

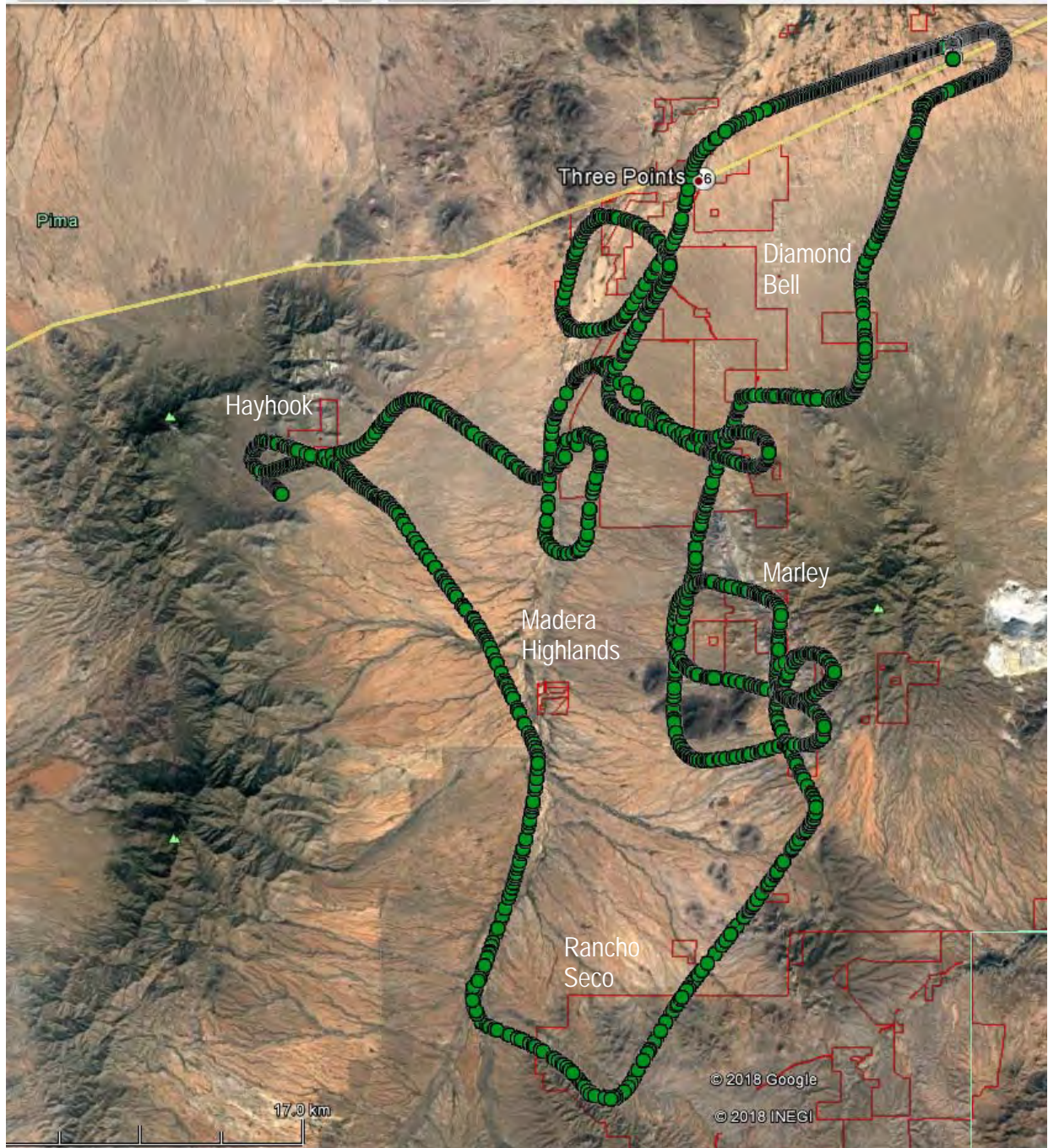


Figure 1: County conservation lands and flight path (green points) used to observe saguaro cacti, inspect woodland cover, and visually identify potential owl habitat from the air in February 2017 in the Altar Valley, Arizona. Red polygons show location of Pima County conservation lands that were considered for surveys. Names of major properties noted in the text are provided in white. Lord's Ranch and Tucson Mountain Park that are County lands that were surveyed for pygmy-owls during this project are located north of the view captured here.

plot representing a potential home range, woodland cover (e.g., proportion of area with >20% woody vegetation cover), and woodland fragmentation developed within each plot with use of a GIS and remote-sensing tools (see details in Flesch et al. 2015). This approach involved extracting spectral vegetation and soil data from 30-m resolution Landsat 5 images from June 2007 (a period with no cloud cover), estimating percent of woody vegetation cover for each pixel, and classifying pixels with $\geq 20\%$ woody vegetation cover as woodland, which, given typical tree spacing, distinguishes open woodland or scrub (<20% canopy cover) from woodland that has a more closed canopy (>20% canopy cover). To quantify woodland fragmentation independent of woodland amount, I scaled density of woodland patches by mean woody vegetation cover (see details in Flesch et al. 2015). Data on woody vegetation cover and fragmentation in these regions were already available from past efforts based on imagery from 2007 (e.g., Flesch et al. 2015). Finally, to estimate saguaro abundance and large tree abundance, I counted the number of adult saguaros (or large trees) within each plot with use of Google Earth imagery and aerial photos from over flights.

Because data on woody vegetation cover for estimating habitat quality were from 2007 when the focus was on adjacent northern Sonora (Flesch et al. 2015), collaborator Dr. Chris Jarchow (U.S. Geological Survey, Southwest Biological Science Center, Tucson) used the same process to estimate woody vegetation cover based on more recent imagery. This effort was focused on obtaining more recent data for the current project area to better index vegetation cover conditions at the time of the surveys. Four Landsat 8 surface reflectance (SR) scenes from the Earth Resources Observation and Science (EROS) Center Science Processing Architecture (ESPA) on Demand Interface were obtained from spring 2015 (Table 1; <http://espa.cr.usgs.gov>). These scenes were combined into a single image that was used to sample spectra corresponding to pure woody vegetation following methods outlined in Flesch et al. (2015). Spectral Mixture Analysis (SMA) in ENVI v5.0 was used to determine the sub-pixel abundance of woody vegetation and discriminate it from soil and other landcover types. Accuracy of the SMA technique for estimating woody cover was facilitated by woody cover estimates based on high-resolution (1 m) National Agriculture Imagery Program imagery covering areas near Tucson from Earth Explorer (<https://earthexplorer.usgs.gov/>).

The final step in the process of estimating habitat quality was combining data on saguaros with that on woody vegetation cover and other factors, and predicting habitat quality within each of the 98 potential home ranges. To predict habitat quality, I used the “predict.lme” function in the *nlme* library in program R together with the original model from Sonora, and based predictions on values of habitat covariates (e.g., percent woody cover, saguaro abundance) measured within each of the 98 plots (Pinheiro and Bates 2000, R Development Core Team 2017). This procedure used the best linear unbiased predictions of the response variable (in this case, reproductive output estimated for owls in Sonora) based on the best supported model from this system (see details in Flesch et al. 2015). When estimating habitat quality for potential home ranges on County lands, I used woody cover estimates derived from both the 2007 and 2015 Landsat data and compared the resulting model predictions to identify any potential sensitivity of model results to temporal differences in imagery.

Once areas of breeding habitat were delineated and the relative quality of those areas estimated, I placed survey transects on the landscape in a way that overlapped as many areas of moderate- to high-quality breeding habitat as possible, while also covering some lower-quality adjacent areas. I placed transects on the landscape in a manner that maximized coverage of such areas so that all survey stations along a single transect were on lands owned or leased by the County. Placement involved positioning single transects along drainages or linear stretches of associated riparian woodlands, subdividing single transects so as to cover multiple drainages in close proximity, or placing survey stations in other arrangements and along roadways to cover existing habitat so that each survey route could be efficiently surveyed during one complete morning or evening survey period. In a few cases, I placed transects in areas County staff selected for surveys based on past

Table 1: Landsat 8 surface reflectance scenes used to prepare 2015 woody vegetation cover layer.

Date	Sensor	Path-Row
23 May, 2015	Landsat 8 OLI	37-38
25 May, 2015	Landsat 8 OLI	35-39
1 Jun., 2015	Landsat 8 OLI	36-39
1 Jun., 2015	Landsat 8 OLI	36-38

observations (e.g., at the base of the Coyote Mountains and on Lord's Ranch), however these areas largely matched estimates of medium to high habitat quality. In total, I established 11 transects of ≥ 2 stations per transect, and placed survey stations at 300-400 m intervals along transects. A small number of survey stations were repositioned, renumbered, or dropped after initial surveys in March 2017 so that transects could be more efficiently surveyed and achieved optimal coverage of target areas.

Pygmy-Owl Surveys—To increase survey efficiency and coverage, I developed a modified version of the research survey protocol approved by the USFWS (2000) and obtained approval for proposed modifications from USFWS staff with the help of County staff (Appendix A). This protocol uses broadcasts of recorded territorial pygmy-owl vocalizations at survey stations placed along point transects to elicit responses from pygmy-owls. Modifications to the USFWS protocol were guided by detailed survey information based on detection of over 600 pygmy-owls throughout Sonora, Mexico. Those data indicate that detectability of pygmy-owls during the nesting season is very high (e.g., 0.89-1.0) from 100-300 m from nests, that owls respond rapidly to call broadcasts (e.g., mean response time = 2.6 min, 99.6% of owls detected in ≤ 8 min), that response rates and detectability remain high at times 2-hours after local sunrise and 1-hour before local sunset, and that owls respond readily before and after nesting (Flesch and Steidl 2007a). Thus, small modifications to the existing protocol to increase its efficiency without altering its effectiveness are possible and desirable from an efficiency perspective. These changes included an initial listening period before call broadcasts at stations of 1 (vs. 2) minute, alternating 30 seconds of call playback at stations with 30-45 (vs. 90) seconds of listening for a total of approximately 6 minutes, and extending survey hours to 3 (vs. 2) hours after sunrise, and 2 (vs. 1) hours before local sunset unless the moon is visible and within ± 3 days of being full in which case surveys may be completed all night as long as the moon is visible (Appendix A). Including a listening period of 1 minute at the end of the final broadcast at stations, each station was visited for a minimum of 8 minutes, and often longer while field gear were being placed in backpacks etc., or due to extending some survey periods due to wind gusts. No surveys were conducted during adverse weather conditions as noted in the established protocol (USFWS 2000).

I surveyed transects two times in spring and once in fall 2017. This effort included one survey during the spring territory-establishment and pre-nesting period in March 2017, one survey during the nesting season in April 2017, and one survey during the dispersal and post-breeding territory-establishment period between in September and October 2017. All surveys of transects were >14 days apart. Because occupancy by pygmy-owls during each of these time periods is indicative of different activities during the life cycle of this species, survey results can help determine the status of owls at sites. Within these periods, myself and occasionally 2 biologists from Pima County surveyed all transects. Effort was focused during periods when the moon was full or nearly full to reduce travel time (i.e., surveys could be completed throughout the night) and multiple transects were often surveyed in single nights.

For all pygmy-owls detected, I noted the time of detection, the estimated distance and bearing to all detections, the time elapsed from the start of broadcasts to detection, sex of owls (where known

based on vocalizations; Cornell Lab of Ornithology 2006), and whether owls were likely calling on or off of County lands. To estimate the number of individual pygmy-owls along each transect, I used information on the distance, direction, and timing of vocalizations, and made special effort to determine if responsive owls were calling simultaneously. In some cases, I remained at stations for longer than eight minutes to estimate number of respondents. Following surveys in April, I also observed owls and searched for nests in occupied areas to confirm pair and nest occupancy. For nests located on lands owned by Pima County and on federal lands, I inspected nest contents with a small, pole-mounted video camera (see [link](#)).

Analyses—I summarized survey results for each season and at the scale of each individual transect among seasons. Information on pygmy-owls observed during surveys was presented as the number of total detections, which did not attempt to differentiate whether responsive owls were the same or different individuals among stations, and the estimated number of individuals, which I determined based on the distance, direction, and timing of vocalizations of responsive owls and any vocalizations heard simultaneously. To assess the efficacy of the habitat-quality model for guiding selection of survey sites, I used *t*-tests to compare estimated habitat quality at stations that were occupied versus those unoccupied within each season. Moreover, across all three survey events, I used Analyses of Variance (ANOVA) to compare estimated habitat quality of stations that were unoccupied versus those that were occupied once, twice, or three times. Because some survey stations were located near more than one of 98 plots in which I estimated habitat quality, I averaged estimates of habitat quality for these points and used these averages for comparisons. Because habitat quality was estimated based on woody vegetation cover measured from both 2007 and 2015 imagery, I compared each set of results in contrasts of occupied versus unoccupied habitat across time.

RESULTS

Effort—I surveyed 11 transects and 87 to 91 stations in each of the three survey periods (Table 2). Although the County called for 10 transects because of budget constraints, an additional short transect of two stations in the Coyote Mountains was surveyed because a pygmy-owl was detected by County staff there in past years and additional survey effort was minimal. Seasonal variation in survey effort (e.g., number of stations surveyed) across time was due to an additional station being added to the Marley 2 transect after initial surveys in March, and one station being removed from the Marley 3 transects after initial surveys in March because it was off of County lease lands. Additionally, on Lord's Ranch only 9 of 13 stations were surveyed in October due to timing issues and personnel availability, although coverage of the best areas was largely unaffected (Table 3). Across the region, effort was greatest on Diamond Bell Ranch (4 transects; 39 stations) and Marley Ranch (3 transects; 18 stations) and lower in the Coyote Mountains and Lord's Ranch, where County properties are small, and in Tucson Mountain Park, where estimates of habitat quality were generally low (Table 3). No transects were placed on Rancho Seco, Madera Highlands, or other, smaller properties in the region due to estimates of low habitat quality.

Survey Results—I detected pygmy-owls along the vast majority of transects selected for surveys, but there was significant seasonal variation in observed patterns of occurrence and abundance (Table 2). In March and October, a remarkable 82% of transects ($n = 9$ of 11) were occupied by one or more territorial pygmy-owls. In October, however, a total of 46% of stations were occupied, which was much higher than in other months (Table 2). During the nesting season in April, occupancy patterns contracted somewhat with only 55% of transects and 30.8% of stations occupied. Across all seasons, pygmy-owls were detected along 91% of transects ($n = 10$ of 11). The only transect without any detections was in the Tucson Mountain Park. The total number of estimated individuals also varied seasonally but less so than occupancy patterns due likely to seasonal differences in movements in response to broadcasts. Abundance peaked in October when 20 estimated

individuals were detected including 3 likely females, whereas in March, 17 individuals were detected including 2 likely females. In April, all 16 individuals I detected were territorial males. Across all seasons, I located a total of 20 distinct territories occupied by territorial males that constitute actual known breeding or potential breeding sites for pygmy-owls.

At the scale of individual transects and specific properties, abundance was greatest along the Coyote Mountains 2 transects where I detected between 4 and 5 individual pygmy-owls during each survey including up to 5 territorial males (Table 3). Abundance was also often high along two of the four transects on Diamond Bell Ranch with an average of 2.7 males detected per survey. Although at least one pygmy-owl was detected along each of three transects on Marley Ranch, abundance was greatest on the Marley 2 transect where 2 males were detected during each of three surveys, with an additional female detected in a new, formally unoccupied area in October. Despite recent release of numerous pygmy-owls bred in captivity on Lord's Ranch five months prior to surveys, no pygmy-owls were detected in the area in spring. One owl was observed by Iris Rodden during surveys on 4 October 2017 on this property, but the presence of a leg band (all of the released owls on this property were banded) could not be ascertained. Survey results standardized by levels of effort (no. stations surveyed) are summarized at the seasonal and transect level in Appendix B.

Pygmy-owls I observed during surveys called from as far away as approximately 1 km from stations. Some of the more distant individuals, however, typically moved closer to stations after initial detection in response to call broadcasts. Thus, although some owls were initially detected off of lands managed by Pima County, in most cases, movement toward survey stations in response to call broadcasts suggested portions of their home ranges included some County conservation lands. Exceptions to this rule included one of two owls detected along the Coyote Mountains 2 transect, which only used areas on the Tohono O'odham Nation and one of a maximum of two pygmy-owls detected along the Marley 3 transect that only used areas on adjacent State of Arizona Trust Lands.

Model Results and Validation—Efforts to estimate habitat quality (as indexed by reproductive output) indicated the presence and fairly broad distribution of moderate- to high-quality breeding habitat across portions of County conservation lands in the Altar and Avra Valleys. Compared to the distribution of observed habitat quality of territories occupied in adjacent Sonora, overall variation in estimated quality of potential territories in adjacent Arizona was lower based on results of 2007 (range = 1.6-3.4) and especially 2015 (range = 1.7-3.3) imagery (Figure 2). On average, however, estimated habitat quality of territories occupied in Sonora was fairly similar to that on County lands based on 2007 ($t = 1.80$, $P = 0.072$) and ($t = 1.79$, $P = 0.074$) 2015 imagery. Nonetheless, estimates based on 2015 imagery averaged $8.6 \pm 1.0\%$ (\pm SE) higher than those based on 2007 imagery ($t = 8.33$, $P < 0.0001$; paired t -test).

Importantly, observed distribution of pygmy-owls among survey stations was associated with the estimated quality of space in the expected directions. However, the presence and strength of these associations varied seasonally in ways consistent with the natural history and timing of breeding and dispersal. During nesting in April, estimated quality of habitat around stations occupied by pygmy-owls was much higher than that around stations where owls were not observed (Figure 3). In comparison, before breeding in March, contrasts in estimated quality between occupied and unoccupied habitat was somewhat less, especially based on 2007 imagery, due likely to broader owl distribution that included some lower-quality areas not occupied in April. When young-of-the-year were dispersing and selecting home ranges in October, however, there was no difference in the estimated quality of occupied and unoccupied habitat around stations, due likely to broader owl distribution and perhaps territory expansion following breeding. On average, estimated quality of stations increased with the number of seasons stations were occupied indicating pygmy-owls used the best sites more consistently across time (Figure 3).

Breeding Status and Nests—I located four nests and three likely nests (e.g., based on abundant owl sign and behavior immediately around likely nest substrates but not contents) during follow-up surveys in April and early May. All nests were in saguaros that averaged 7.0 m tall (range = 4.3-8.7). Nest cavity heights averaged 6.0 m (range = 4.1-8.6) and nest-cavity dimensions suggested excavation by Gila Woodpeckers (*Melanerpes uropygialis*). Confirmed nests contained an average of 4.5 eggs (3 with 5 eggs, 1 with 3 eggs) and were located on either County-owned or federal lands (Bureau of Land Management; Figure 4). Nests and likely nests were located between 846 and 1,177 m elevation, at an average elevation of 1,038 m, and all sites were in semi-desert grassland environments, with one exception in desert-scrub. Along the Coyote Mountains 2 transect, I located three nests and an additional occupied site in close proximity (Figure 4). An upper-elevation nest along a rocky draw was 595 m away from a neighboring nest in wooded flats at lower elevation below. The latter nest was 735 m above a historical site monitored by the USFWS on and off since 2000 (e.g., Mendoza south) that was occupied by a territorial male during this study (that could have—but did not appear—to be nesting nearby), and 1,255 m above another nest located in the same broad wooded flat but at lower elevation. On Diamond Bell Ranch, two nests were located 570 m apart along adjoining wooded drainages. Another likely nest was located 615 m from a formally occupied nest and apparently the same historical site monitored by USFWS since 2012 (e.g., SR 286). In addition to the site at Lord’s Ranch where numerous pygmy-owls bred in captivity were released in 2016, the two aforementioned historical sites were the only documented localities for pygmy-owls on County lands known by USFWS before this work.

Except where noted above, most pygmy-owls I detected in April were paired, nesting, or exhibiting behaviors suggesting nesting. One additional exception was observed along the Coyote Mountains 2 transect where a territorial male and a female were present but did not seem to be nesting in two nearby saguaros I inspected with a pole-mounted video camera. These birds could have possibly nested in saguaros located approximately 300 m away but immediate responses from around the two aforementioned saguaros suggested otherwise. Another exception was at the Marley 2 transect where one of two territorial males was apparently not paired or nesting based on focused observations and nest searches. The majority of this owl’s likely territory was on adjacent State of Arizona Trust Lands that supported a few saguaros that this owl may have been nesting in, but it was not nesting in saguaros on the portion of its territory that was on County lands.

Table 2: Summary of effort and survey results for each of three visits to 11 transects located on Pima County conservation lands in the Altar and Avra valleys, Arizona, that were surveyed for Cactus Ferruginous Pygmy-owls in 2017. M denotes males and F denotes females as determined based on vocalizations.

Survey period	Dates	Transects (no.)	Stations (no.)	Occupied transects		Occupied stations		Detections		Individuals		M	F
				no.	%	no.	%	total	no./effort	total	no./effort		
March	9-14	11	91	9	0.82	32	35.2	38	0.42	17	0.19	15	2
April	11-26	11	91	6	0.55	28	30.8	31	0.34	16	0.18	16	0
October	4-18	11	87	9	0.82	40	46.0	44	0.51	20	0.23	17	3

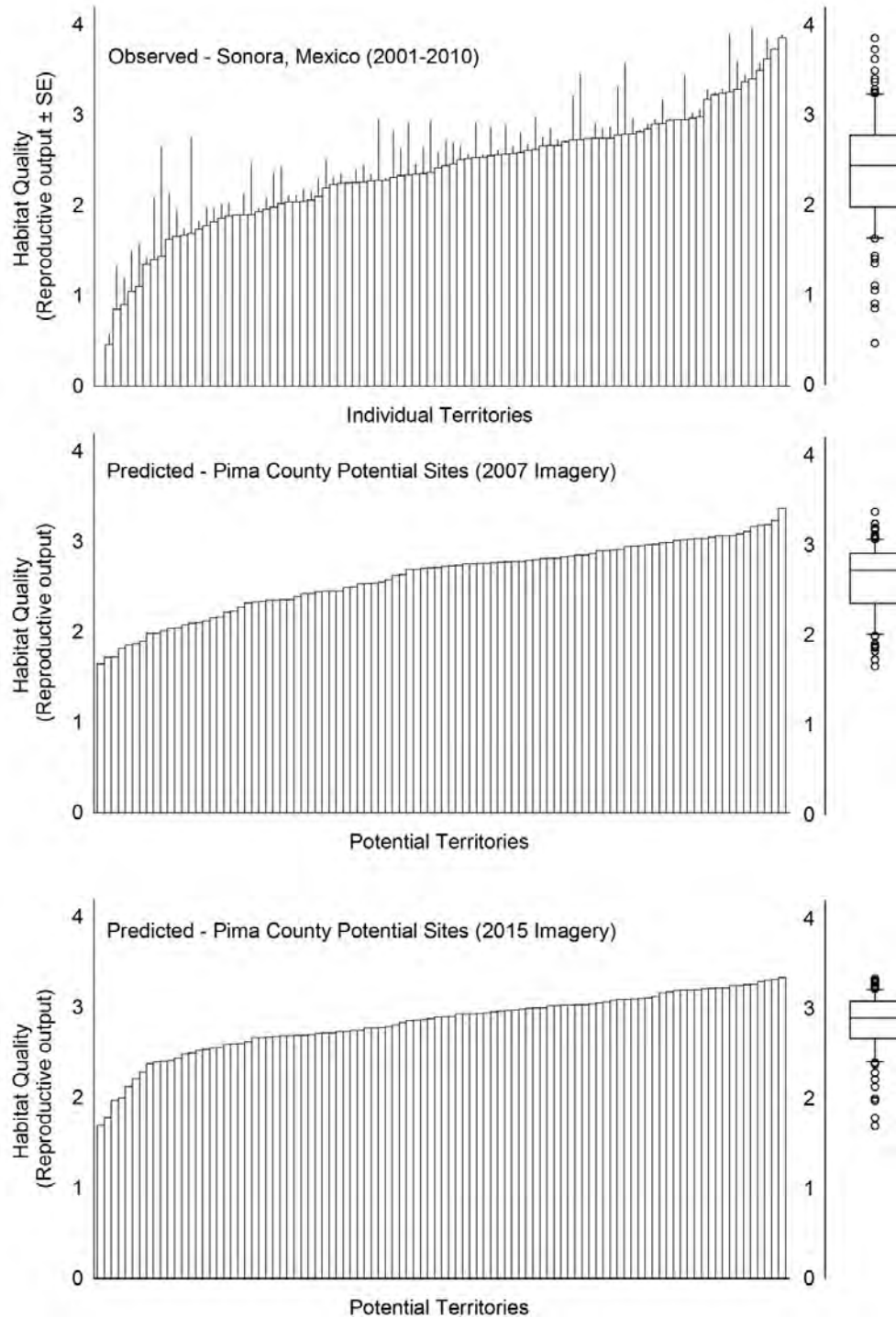


Figure 2: Observed and predicted territory quality as indexed by model-based estimates of annual reproductive output of Cactus Ferruginous Pygmy-owls. Bars are actual (Sonora) or potential (Arizona) individual territory patches ordered from low to high. Estimates are based on a model from Sonora and observed reproductive output at almost 500 nests over 10 years (Flesch et al 2015). Box plots show distribution of observed and estimated reproductive output with center lines noting medians and boxes 75% of data. Middle figure noted estimates based on woody vegetation cover from 2007 Landsat imagery whereas those on bottom from 2015 imagery.

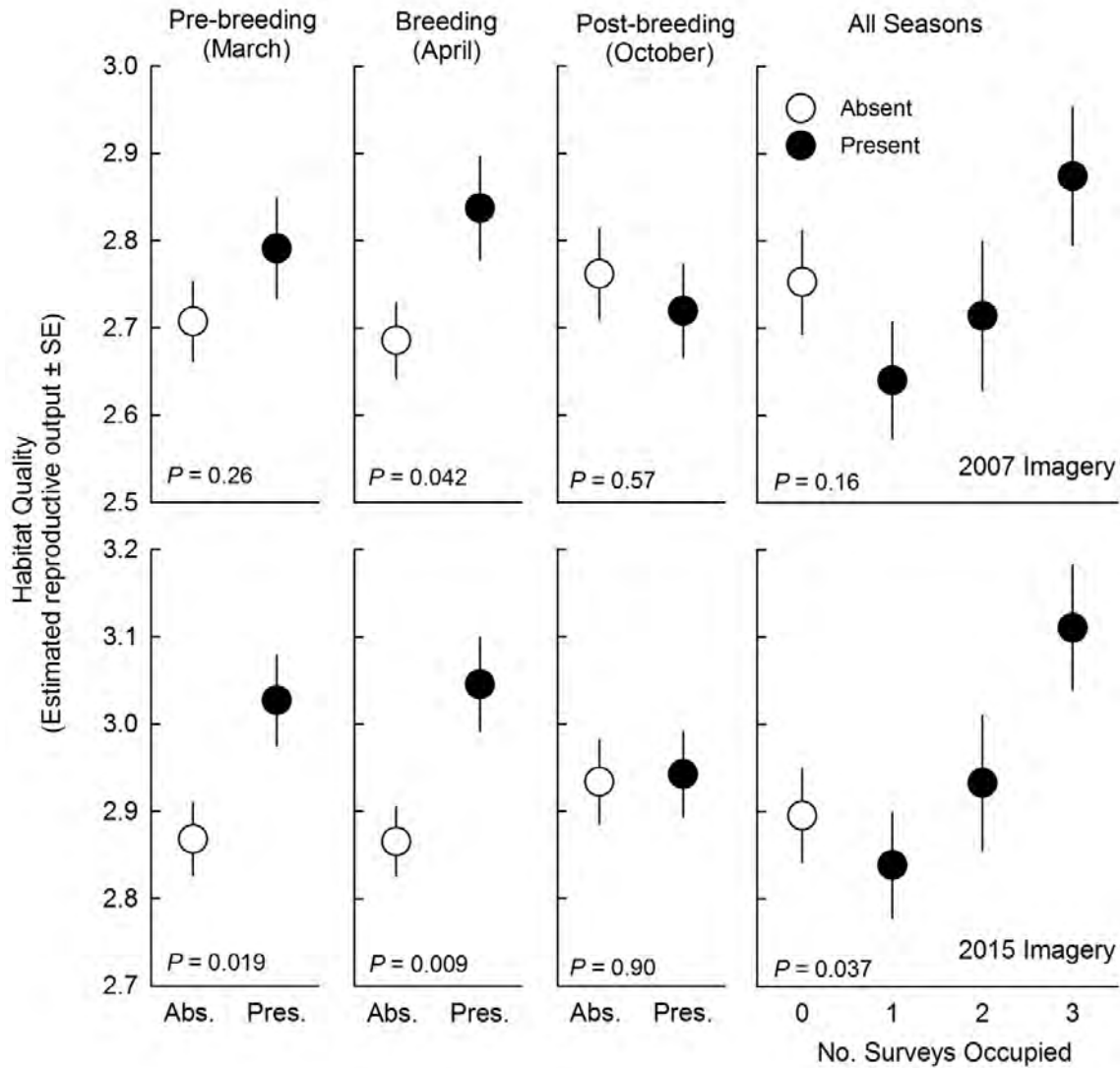


Figure 3: Estimated habitat quality (as indexed by predicted reproductive output) of areas where Cactus Ferruginous Pygmy-owls were present and not detected during surveys of Pima County Conservation lands in the Altar and Avra valleys, Arizona across three different seasons in 2017. Right figures show estimated habitat quality of areas where pygmy-owls were detected zero, one, two, or three times across the three survey events. Top panel shows predictions of habitat quality based on estimates of woody vegetation cover from 2007 Landsat imagery whereas those in the bottom panel are based on 2015 Landsat imagery. *P*-values are based on two-sample *t*-tests (left) or Analysis of Variance (right).



Figure 4: Cactus Ferruginous Pygmy-owl nest sites, nesting habitat, and nest contents on Pima County conservation lands in the Coyote Mountains, Arizona, April 2017. Nest saguaros in the top left, and middle panels were located 595-1,255 m apart with arrows indicating location of nest cavities, whereas top right panel shows nest habitat along a rocky drainage around the same nest shown in the adjoining panel. Nest contents within saguaro cavities are shown for the top- and middle-left panels. Contents of the nest in the middle-right panel were not visible due to small cavity entrance area.

Table 3: Summary of effort and survey results for each of 11 transects located on Pima County conservation lands in the Altar and Avra valleys, Arizona, surveyed for Cactus Ferruginous Pygmy-owls in March, April, and October 2017. Transects are names based on the ranches or regions they traversed and are listed alphabetically. All owls detected along transects are included despite the fact that some owls noted in the text were largely using lands adjacent to County lands, but not managed by Pima County. Thus, in some cases, individual owl's territories likely included lands both on and off of County lands.

Transect	Stations	Occupied Stations			Detections			Individuals			Males		
	no. or range	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Coyote Mountains 1	2	2.0	2	2	2.3	2	3	2.0	2	2	2.0	2	2
Coyote Mountains 2	7	7.0	7	7	8.7	7	10	4.3	4	5	3.7	3	5
Diamond Bell 1	10	3.3	3	4	3.3	3	4	1.0	1	1	1.0	1	1
Diamond Bell 2	11	5.7	0	9	6.3	1	10	2.7	1	4	2.7	1	4
Diamond Bell 3	9	3.3	0	5	3.3	0	5	1.0	0	2	0.7	0	1
Diamond Bell 4	9	4.3	3	5	5.0	3	7	2.7	2	3	2.7	2	3
Lord's Ranch	9-13	0.3	0	1	0.3	0	1	0.3	0	1	0.0	0	0
Marley 1	6	1.0	0	3	1.0	0	3	0.3	0	1	0.3	0	1
Marley 2	6-7	4.7	3	6	5.7	3	8	2.3	2	3	2.0	2	2
Marley 3	5-6	1.7	0	4	1.7	0	4	1.0	0	2	1.0	0	2
Tucson Mt. Park	12	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0

DISCUSSION

I located a fairly large population of pygmy-owls on Pima County conservation lands in the northern Altar Valley in 2017. This achievement was fostered by quantitative tools developed in adjacent Sonora, Mexico, data from aerial reconnaissance and remote sensing, and a well-formed search image for pygmy-owl habitat developed over two decades of experience in the Sonoran Desert. Importantly, many sites occupied by pygmy-owls that I located were unknown to scientists, managers, and policy makers in the recent past. With the exception of two known historical sites monitored by USFWS in the Altar Valley and a site at Lord's Ranch where pygmy-owls bred in captivity were recently released, 17 territories occupied by pygmy-owls that I documented were not known before work presented here (Flesch 1999, 2003a, Flesch et al. 2017, S. Richardson, USFWS, pers. comm.). These new sites roughly double the known population of recently occupied sites in the northern Altar and adjacent Avra valleys in Arizona ($n = 18$). Moreover, these results also expand the spatial extent of the known distribution of pygmy-owls in Arizona, and increased the population of historical sites monitored by USFWS and collaborators since the early 1990s ($n = 39$) by 44%. In combination with management strategies that preserve and perpetuate the continued existence of habitat, these results confirm the value of Pima County conservation lands for the Cactus

Ferruginous Pygmy-Owl. Importantly, baseline data reported here also provide a strong foundation upon which to build subsequent monitoring efforts, which was a major goal of this effort.

Auspiciously, among the more important findings of this work is that pygmy-owls are somewhat more common and broadly distributed than was previously known in the northern Altar Valley, and in southern Arizona in general. This result combined with recent observations from long-term monitoring in Arizona, which indicates territory occupancy of populations in the lower Brawley (Altar) Valley has increased recently (Flesch et al. 2017), offers excellent prospects for recovery and conservation of pygmy-owls in southern Arizona. These results, however, sharply contrast patterns near Tucson, in the upper Brawley Valley, and in areas to the north and east of Tucson where populations of pygmy-owls have been extirpated recently or during the past century and there is no recent evidence of occupancy (Johnson et al. 2003, USFWS 2011, Flesch et al. 2017). Such results are especially noteworthy given the relatively low levels of survey effort implemented here (e.g., 91 stations along 11 transects) and suggest numerous additional territories remain to be discovered on lands managed by Pima County and perhaps other entities in this region. To this end, more survey effort on Diamond Bell Ranch, which is vast and supports a broadly distributed population of saguaros, and of lower quality sites assessed but not surveyed (most of which are on Diamond Bell), are likely to yield additional territories and nesting locations.

I largely validated the utility of an important quantitative tool for estimating habitat quality for pygmy-owls in southern Arizona and identifying areas on the landscape to prioritize for surveys. Despite the relative rarity of pygmy-owls across the broader landscape, virtually all transects I identified for surveys with use of this tool were occupied by one or more pygmy-owls at some point in the sampling period, and more than half of transects I selected for surveys were occupied during the breeding season. Importantly, distribution of pygmy-owls observed during surveys was associated with the estimated quality of space in the expected directions, further validating the utility of such modeling efforts to identify priority survey sites. In fact, estimated habitat quality of areas occupied by pygmy-owls was higher on average than that of areas where pygmy-owls were not detected during most seasons (particularly during the breeding season), with strong evidence of the expected positive relationship between persistence in occupancy and estimated habitat quality based on theory (Fretwell 1970, Sergio and Newton 2003, Flesch 2017). Such results provide strong evidence this approach is both sufficiently sensitive and based on appropriate indicators of habitat suitability to be broadly applicable for this and other applications. Nonetheless and not surprisingly, more recent measurements of woody vegetation cover yielded better estimates of habitat quality because they best matched observed owl distribution in the field. Given observed successes, the techniques used here should also offer a rigorous, evidence-based approach to identify and select optimal sites for habitat restoration, habitat enhancement, and sites for releases of pygmy-owls bred in captivity or via facilitated dispersal.

Monitoring Implications—Presence of a fairly large and broadly distributed population of pygmy-owls on Pima County conservation lands in the Altar Valley offer excellent prospects and strong foundations upon which to build subsequent monitoring efforts. To this end, monitoring both territory occupancy (no. of territories occupied), abundance (total number of males), and relative abundance (no. per unit effort) along transects is possible with the methods and data described here. Additional information on the extent, nest locations, and status of some territories, however, will aid development of rigorous occupancy monitoring, which can be pursued in future years and is described in detail by recent nearby efforts (e.g., Flesch et al. 2015, 2017). These parameters and similar methods have been highly effective for monitoring and illuminating the patterns and drivers of population dynamics of pygmy-owls in adjacent northern Mexico (Flesch and Steidl 2006, Flesch 2014, Flesch et al. 2017), and offer great promise for subsequent monitoring on Pima County conservation lands.

In advance of future efforts, a number of design and methodological considerations are useful to guide monitoring. With regard to the seasonal timing and frequency of surveys, monitoring inferences do not necessarily need to be based on three repeated surveys of the same transects in different seasons, even though such effort is helpful for determining persistence of occupancy. Given high detection probability of pygmy-owls using the methods described here (Flesch and Steidl 2007a) reducing survey intensity to one or perhaps two surveys per year seems warranted. This is especially the case if it liberates resources for surveying more area within a given year or the same areas with greater frequency of every year or every two years (e.g., instead of every three years as currently written into Pima County's MSCP). Limiting surveys to the nesting season (April and May) will focus inferences on territorial males that are potentially breeding, which is likely the most useful population attribute for monitoring (particularly over the 30 year term of the MSCP) despite higher abundance before and especially after the breeding season (Flesch and Steidl 2006, 2007). In Sonora, one survey per year during the nesting season at both the transect and territory-patch scale has proven to be an effective index for monitoring (Flesch and Steidl 2006, Flesch 2014, Flesch et al. 2017). However, surveys before and after the nesting season are useful for identifying occupied areas on the landscape even if these areas are more likely to be of lower quality than those occupied during the nesting season. Surveys following breeding and after the initiation of dispersal, however, may be useful for indexing annual reproductive output and subsequent survival, which may be desirable in some contexts. Finally, integrating monitoring on Pima County conservation lands with that conducted opportunistically by USFWS and their collaborators in the region, and more consistently in adjacent Sonora (see Flesch et al. 2017), could greatly bolster the success, scope and quality of inferences of efforts. This is because the dynamics of population units in some areas are likely influenced by similar drivers, given greater travel efficiency, and because larger sampling frames and sample sizes can augment statistical power and precision of trend and other estimates.

Management Implications—Despite observed associations between occupancy and estimated habitat quality just before and during the nesting season, there was no difference in estimated quality during October when young pygmy-owls are dispersing and selecting home ranges. This contrast provides useful insights into population processes and potentially population limitation in the region that have important implications for management. Animals typically select the best quality territories that are available first and occupy these sites more consistently over time (Newton 1998, Sergio and Newton 2003). Such patterns have been demonstrated in the field over fairly long time periods for pygmy-owls in adjacent Sonora, Mexico (Flesch 2017). Once independent from their parents, young-of-the-year pygmy-owls (and many other resident or non-migratory birds) in the region disperse in late summer and early fall, and settle either as territorial individuals in available territories or become non-territorial floaters in or at the edge of territories occupied by other individuals that are often older and more experienced (Flesch and Steidl 2007b, Flesch et al. 2010). By the time young birds are selecting territories of their own, overall population abundance is typically at its annual peak due to recent breeding activity and generally favorable conditions, and thus the best sites are often occupied by more dominant individuals. If abundance is high, young dispersing pygmy-owls selecting home ranges at this time are therefore often relegated to territories of lower quality. My results corroborate these general patterns by indicating higher overall occupancy rates and abundance in October and no difference in the estimated quality of occupied and apparently unoccupied areas at this time based on assessments of a large number of potential territories that are broadly representative of potential pygmy-owl habitat on County conservation lands. Although to some degree, habitat selection may rely on some different cues following breeding, and territorial expansion may also contribute to these patterns, occupancy of lower quality areas when abundance was high likely influenced these results. In combination with the relatively large and broadly distributed population I documented, these patterns suggest pygmy-owls already occupy some of the better quality potential sites in the northern Altar Valley but other sites mainly off of County lands remain to be detected. As such, habitat area and habitat quality rather than dispersal limitation or lack of adequate landscape connectivity to foster local immigration likely limit population size of pygmy-owls in this region. Hence, introducing new individuals from captive

breeding or facilitated dispersal into this system is likely to have little influence on population size unless managers simultaneously increase habitat area and quality, or if over-winter or potentially drought-induced mortality is high and releases are timed to compensate for such declines. Instead, releases of pygmy-owls should focus on areas where dispersal limitation due to habitat isolation by urban or agricultural growth or where relatively high distances from the nearest breeding populations are driving population limitation (Newton 1998). For pygmy-owls, landscape structures such as major highways, urban development, and large agricultural fields affect both movement and colonization success during dispersal, reduce landscape connectivity, and influence distributional dynamics at among-landscape scales (Flesch and Steidl 2007b, Flesch et al. 2010, Flesch 2017).

Conservation of pygmy-owls and their habitat on Pima County conservation lands can be aided by a number of guiding principles in combination with information on the context they occupy. First, many sites occupied by pygmy-owls in the region are at relatively high elevations for the species (e.g., >1,000 m) or in other areas where abundances of saguaro cacti are also low. In such contexts, availability of nest cavities, not woody vegetation cover, generally limits both the area and quality of habitat (Flesch 1999, 2003b, Flesch and Steidl 2010, Flesch et al. 2015). Thus, many pygmy-owls that occupy this region nest in one of very few, if not the only, potential nest substrates in their home ranges. Without these nest substrates and the cavities they provide, breeding habitat for pygmy-owls would otherwise not exist. In contrast, tree cover especially that dominated by mesquite, which promotes occupancy more than other desert tree species (Flesch 2003b), is fairly abundant across large areas including many that fail to provide habitat due to absences of potential nest sites. Hence, strategies that foster the reproduction, recruitment, and survival of saguaro cacti, and continued existence of primary excavators such as Gila woodpeckers, are the most fundamental guideline for conservation and management of pygmy-owls on Pima County conservation lands in the study region described here. This is especially the case for saguaros that are associated with xeric or mesic riparian woodlands and other wooded areas dominated by mesquite trees, which are more likely to provide habitat for pygmy-owls.

Most Pima County conservation lands I surveyed are grazed by domestic livestock. Assuring this and other ongoing land uses are consistent with the maintenance and continued existence of habitats for pygmy-owls and other listed species is important to strengthen the reliability of existing conservation mechanisms and success of the Sonoran Desert Conservation Plan. Livestock grazing can have both positive and negative impacts on habitat suitability for pygmy-owls. On one hand, grazing effects on pygmy-owl occupancy were greater in areas where saguaros were sparse, but grazing also creates openings and reduces ground cover, which at small scales can enhance visibility and likely habitat selection for pygmy-owls, especially in areas with high vegetation volume (Flesch 2003b, Flesch and Steidl 2010). However, livestock grazing has also been found to negatively influence regeneration of saguaro cacti (Niering et al. 1963, Niering and Whittaker 1965, Steenbergh and Lowe 1977, Abouhaider 1989, 1992), and high levels of grazing negatively influence abundance and diversity of prey taxa including species of lizards and small mammals that are major prey of pygmy-owls (Jones 1981, Fleischner 1994, Hayward et al. 1997, Flesch pers. obs.). Thus efforts to ensure grazing levels and management on Pima County conservation lands will foster recruitment of this keystone species are essential and warrant future studies. Depending on the results of these assessments, efforts to protect areas with high potential for saguaro establishment and recruitment, potentially by erecting localized fenced livestock enclosures, merit consideration.

In areas where potential nest cavities are naturally sparse or have been lost due to fire, invasion of exotic grasses, overgrazing, or natural patterns of infrequent and highly episodic recruitment of saguaros (Pierson and Turner 1998), active efforts to augment nest cavities could have major benefits for pygmy-owls. Such techniques include erecting nest boxes or translocating salvaged saguaros to create new habitat in areas where suitable woodlands are already present, or enhancing existing habitat by augmenting availability of potential nest cavities. Such techniques can be combined with existing information on nest heights and cavity dimensions and orientations selected

by pygmy-owls, which have major effects on reproduction, and used effectively to enhance or create habitat across large areas (see Flesch and Steidl 2010). Moreover, increasing abundances of potential nest cavities will increase the quality of existing habitat by reducing predation, competition, and interspecific aggression with other species of cavity nesters, especially larger heterospecific enemies such as western screech owls (*Megascops kennicottii*; Flesch and Steidl 2010, Flesch et al. 2015).

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APPENDIX A - PIMA COUNTY CACTUS FERRUGINOUS PYGMY-OWL SURVEY PROTOCOL

Developed by: Aaron D. Flesch, University of Arizona, School of Natural Resources and the Environment, Brian Powell, Pima County Office of Sustainability and Conservation, Ian Murray Pima County Office of Sustainability and Conservation

INTRODUCTION

We will follow a similar protocol to that outlined under the large survey area – research protocol described by USFWS (2000). We made various small modifications to this protocol to augment efficiency without reducing its reliability based on research recently completed in neighboring northern Sonora, Mexico (Flesch and Steidl 2007a, Flesch 2013, 2014). Detailed survey information based on >600 individual pygmy-owls in Sonora indicates that detectability of pygmy-owls during much of the breeding season is high (0.89-1.0 from 100-300 m from nests), that owls respond rapidly to call broadcasts (mean response time = 2.6 min, 99.6% of owls detected in ≤ 8 min), and that response rates and detectability remain high at times 2-hours after local sunrise and 1-hour before local sunset (Flesch and Steidl 2007a). Therefore, we will propose some small modifications to the existing protocol to increase its efficiency without altering its effectiveness. The material below includes original and modified text from USFWS (2000).

PROTOCOL DETAILS

1. A valid Arizona Game and Fish Department Scientific Collecting License outlining relevant permissions to carry out pygmy owl surveys must be held by the primary surveyor for all surveys. Permission to access a property for surveying must be obtained from each private property owner or those having management authority (public lands) prior to conducting surveys. Where permission cannot be obtained from adjacent landowners, call stations should be placed on the property boundary and public roads without trespassing so that coverage may be extended to adjacent areas.
2. Call stations should be surveyed twice during the spring with one survey during the territory-establishment period between approximately February 1 and March 31 and one survey during the nesting season between April 1 and June 15. There should be at least 15 days between each spring survey at a given site. Additionally, stations should be surveyed once in the fall shortly after the period when juveniles are dispersing. These surveys will focus between September 15 and October 31 and allow detection of juveniles that may have recently settled in the area as well as any previously documented resident individuals.
3. Surveys should be conducted in potential habitat from 1 hour before sunrise to 3 hours after sunrise, or from 2 hours before sunset to 1 hour after sunset (use an official sunrise table for correct times). Surveys may also be conducted at night during a full moon or nearly full moon three days on either side of a full moon while the moon is visible. If the moon sets or is obscured by clouds, surveys should not be conducted.
4. Surveys should not be conducted under adverse weather conditions (e.g., moderate or strong winds [greater than 12 mph] or during rain). Under these conditions, owls may not be able to hear broadcasted calls and the surveyor's ability to hear an owl response may be reduced. In addition, surveys should not be conducted at call stations that have loud noises (e.g., traffic, aircraft, barking dogs, etc.) that reduce the effectiveness of broadcasted calls or impair the surveyor's ability to hear responding owls. Call stations should be placed away from noisy areas or rescheduled for another time (e.g., weekends when there is less traffic in urban areas), and where possible placed on elevated wash terraces or other areas that aid listening vs. in deep wash channels or depressions

that may obstruct sounds. The survey period spent at stations with periodic noise (e.g., aircraft, traffic, etc.) should be extended to compensate for periodic noisy survey conditions if they cannot be avoided.

5. Call stations along survey transects should be spaced at no more than 500 m (0.3 mi) apart with most stations placed 300-400 apart depending on terrain, location of nesting substrates, and coverage needs. Call stations in mesic riparian areas that support tall gallery forest should be no more than 300 m apart due to tree density and noise. In areas where habitat is widely spaced, where a single transect is placed along multiple wash channels so as to cover distant habitat patches, or where land in-holdings are present, stations can be placed further away.

6. At each call station prior to broadcasting a taped call we will listen for a 1-minute period. This will allow the surveyor to detect any spontaneous calling and also to become familiar with features at the station (i.e., large trees or saguaros, residences, water sources, etc.) that may affect pygmy-owl presence or detectability.

7. Following the initial listening period, the surveyor will broadcast CFPO calls for 30 seconds, followed by a 30-45 second listening and observation period. The surveyor should broadcast calls in all directions of habitat. The volume should be set to an adequate level to get complete coverage along a survey route without causing distortion of the call. Equipment used should be able to produce a loud, clear call without distortion and a sound level between 95-105 decibels at a distance of 1 m from the speaker (Proudfoot et al. 2002).

8. Repeat this calling/listening sequence for at least 6 minutes. Extend this sequence for up to an additional 5 minutes or more if noise disturbances such as barking dogs, air traffic or vehicles cannot be avoided and they affect your broadcast or ability to hear (see number 6 above).

9. During the survey/listening sequence, the surveyor should periodically scan trees and cactus (particularly cavities and trees) for pygmy-owls that may be present but not vocalizing. Binoculars should be used to assist the surveyor locate owls. A rangefinder and compass may be used to estimate the direction and distance of any responding owls. Note any mobbing behavior by other birds in response to the tape broadcast and investigate appropriately.

10. After completing the 6-minute broadcast/listening sequence, we will observe and listen for an additional 1 minute before placing gear away and proceeding to the next call station. Any detections following this 1-minute period that occur at the station will be noted as having occurred at the station. Combined with the initial 1-minute listening period, the total time spent at each call station should be a minimum of 8 minutes.

11. For each route surveyed, we will complete a datasheet that includes the following data fields: survey date, survey time, surveyor, weather conditions, moon phase, official sunrise or sunset time, location and elevation of each calling station (UMT), and the distance between successive stations. For each pygmy-owl detection, we will note the time elapsed from the start of broadcasts to detection, the sex of owls based on vocalization, the call type (territorial call, chitter call, alarm call), the initial distance and direction to owls from the station, the final detection distance, the number of pygmy-owls detected, and whether the owl was detected at the prior station or represents a new individual. We will use the distance, direction, and timing of responses to discriminate multiple individual pygmy-owls. For owls detected while walking to neighboring stations, we will record this same information and note the distance to the closest station. Other species of owls detected at stations will also be noted.

12. In order to maximize the efficiency of inter-agency species management efforts, any positive detections of pygmy-owls will be sufficiently documented and communicated to the local USFWS office.

Copies of all datasheets and survey maps will be shared with the USFWS and AGFD during annual scientific collecting license renewal.

If a pygmy-owl is heard or seen:

1. End call broadcast at the station to avoid harassing the owl, unless additional responses are needed to pinpoint location of the pygmy-owl. Estimate the direction and distance of the initial location of pygmy-owl detection (e.g., using a rangefinder and compass), as well as the time required for the initial response. Sex of the responding owl should also be noted where possible.
2. Place the next broadcast station a minimum of 500 m away so that additional owls can be detected in the area and those individuals can be discriminated from owls already observed at prior stations based on distance, direction, and timing of responses.
3. After the survey route is complete and where possible, observe the pygmy-owl without disturbing it (i.e., do not chase the owl or harass it with calls). Record all observations, use of cavities and prey observations are especially important. Listen for female or fledgling vocalizations or other evidence that there may be other pygmy-owls in the area.
4. Record owl locations using UTM (NAD 83) coordinates and ensure all relevant data such as survey date, time, weather conditions, moon phase, official sunrise/sunset times, and responses of any other bird species are accurately and legibly filled out.

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APPENDIX B – SURVEY RESULTS STANDARDIZED BY EFFORT AS MEASURED BY NUMBER OF SURVEY STATIONS FOR EACH SEASON AND TRANSECT.

Table S1: Survey results standardized by effort (no. of stations) across each of three seasonal visits and all visits to 11 transects located on Pima County conservation lands in the Altar and Avra valleys, Arizona, surveyed for Cactus Ferruginous Pygmy-owls in 2017.

Survey period	Occupied Stations/Effort		Individuals/Effort		Males/Effort	
	Mean	St. Err.	Mean	St. Err.	Mean	St. Err.
March	0.462	0.122	0.271	0.089	0.248	0.086
April	0.365	0.122	0.246	0.101	0.246	0.101
October	0.521	0.114	0.301	0.090	0.265	0.088
<i>All Seasons</i>	<i>0.449</i>	<i>0.045</i>	<i>0.273</i>	<i>0.016</i>	<i>0.253</i>	<i>0.006</i>

Table S2: Survey results standardized by effort (no. of stations) across each of three seasonal visits and on average for each of 11 transects located on Pima County conservation lands in the Altar and Avra valleys, Arizona, surveyed for Cactus Ferruginous Pygmy-owls in 2017.

Transect	Occupied Stations/Effort			Individuals/Effort			Males/Effort		
	Mar.	Apr.	Oct.	Mar.	Apr.	Oct.	Mar.	Apr.	Oct.
Coyote Mountains 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Coyote Mountains 2	1.00	1.00	1.00	0.57	0.71	0.57	0.43	0.71	0.43
Diamond Bell 1	0.30	0.30	0.40	0.10	0.10	0.10	0.10	0.10	0.10
Diamond Bell 2	0.00	0.73	0.82	0.09	0.27	0.36	0.09	0.27	0.36
Diamond Bell 3	0.56	0.00	0.56	0.22	0.00	0.11	0.11	0.00	0.11
Diamond Bell 4	0.56	0.56	0.33	0.33	0.33	0.22	0.33	0.33	0.22
Lord's Ranch	0.00	0.00	0.11	0.00	0.00	0.11	0.00	0.00	0.00
Marley 1	0.50	0.00	0.00	0.17	0.00	0.00	0.17	0.00	0.00
Marley 2	1.00	0.43	0.71	0.33	0.29	0.43	0.33	0.29	0.29
Marley 3	0.17	0.00	0.80	0.17	0.00	0.40	0.17	0.00	0.40
Tucson Mountain Park	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Average</i>	<i>0.46</i>	<i>0.36</i>	<i>0.52</i>	<i>0.27</i>	<i>0.25</i>	<i>0.30</i>	<i>0.25</i>	<i>0.25</i>	<i>0.26</i>

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 10

Chiricahua and Lowland Leopard Frog Monitoring Protocol

Pima County Ecological Monitoring Program

Leopard Frog Monitoring Protocol

December 2018



Chiricahua Leopard Frog
(*Lithobates chiricahuensis*)



Lowland Leopard Frog
(*Lithobates yavapaiensis*)

Prepared by Pima County Office of Sustainability and Conservation Staff:
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Abstract

This protocol covers the structure and results for Pima County's first round of monitoring both Chiricahua and lowland leopard frogs, under its Multi-species Conservation Plan (MSCP) and Section 10 permit from the U.S. Fish and Wildlife Service (USFWS). Pima County has agreed to monitor the occupancy of lowland leopard frogs at six different riparian sites (Youtcy Canyon, Espiritu Canyon, Edgar Canyon, Buehman Canyon, Bullock Canyon, and Cienega Creek) on County lands every three years. The County has also agreed to monitor the occupancy of any newly established Chiricahua leopard frog populations on County lands on an annual basis for the first three years, and thereafter every three years. We used a visual encounter survey method during leopard frog surveys and although there was variation in how leopard frogs were distributed across a site, we confirmed that lowland leopard frogs occupied all six sites during 2018. Chiricahua leopard frogs are currently known to occupy two sites on County lands, and both of these sites were occupied during 2018. Although our 2018 leopard frog monitoring results are the first under the County's MSCP, as key riparian indicator species, County staff have been tracking occupancy of lowland leopard frogs at most of these sites on an annual basis since approximately 2011.

Acknowledgements

We would considerably like to thank David Hall (University of Arizona) for his efforts in surveying for Chiricahua leopard frog and managing invasive species at Hospital Tank and Goat Well Pond. We thank Don Carter for his critical role in developing the Goat Well Wildlife Pond as Chiricahua leopard frog habitat. We also acknowledge the many years of work that Brian Powell and Don Swann have invested in monitoring and tracking leopard frogs, especially lowland leopard frogs, on and off County lands. We thank Mead Mier and Melanie Alvarez of Pima Association of Governments, and Doug Siegel and Rachel Loubeau of NRPR, for organizing quarterly wet-dry mapping of Cienega Creek. Mike List provided key GIS expertise and guidance for plot placement. Pima County's Ecological Monitoring Program Science and Technical Advisory Team members for assistance with program design and protocol review.

Background & Objectives

Six species of leopard frogs (family: *Ranidae*, genus: *Lithobates*) occur in riparian habitats of Arizona. Of those species, the Chiricahua Leopard Frog (*Lithobates chiricahuensis*) and Lowland Leopard Frog (*Lithobates yavapaiensis*) occur in the Sonoran Desert and sky islands waters of eastern Pima County. Pima County's Sonoran Desert Conservation Plan identified both species for coverage due to widespread population declines and extirpations among both species as well as for their ecological significance in riparian systems. Additionally, the Chiricahua leopard frog is a federally protected species. The County's Multi-species Conservation Plan (MSCP) ensures that the County remains in compliance with its Section 10 incidental take permit that it has been issued from the U.S. Fish and Wildlife Service. As part of the MSCP, Pima County has agreed to monitor Chiricahua and lowland leopard frog populations on County conservation lands (Pima County 2016).

The Chiricahua leopard frog (CLF) is a mid-sized (maximum ~110 mm snout-vent length) frog known to historically occur broadly throughout the Gila and Verde River watersheds, as well as parts of Mexico. However, the species is estimated to be extirpated in ~88% of its historic localities (in the United States), and currently occurs primarily in stock tanks and other man-made waters in southern Arizona. The U.S. Fish and Wildlife Service listed CLF as threatened in 2002 due to chytridiomycosis exposure (i.e., chytrid fungus) and subsequent catastrophic population declines, non-native species predation and competition, and habitat loss and degradation (USFWS 2007). As of December 2018, CLF are currently known to occur in two sites on Pima County conservation lands: 1) Hospital Tank (Clyne Ranch), and 2) Goat Well Pond (Sands Ranch). Hospital Tank is a non-supplemented, rainwater-fed dirt livestock tank, while Goat Well Pond is a constructed, well-fed pond adjacent to an existing ephemeral livestock tank that Pima County built to provide habitat for CLF as well as a wildlife water source.

The lowland leopard frog (LLF) is a small (maximum ~86 mm snout-vent length) frog known to historically occur broadly throughout perennial waters in central and southern Arizona, southwestern New Mexico, parts of southeastern California, and Sonora, Mexico, from near sea level up to 2,000 m. The species' range has been reduced somewhat, due to the decrease in perennial water availability in many low lying streams, the introduction of nonnative and invasive species such as bullfrogs, crayfish, and various fishes, and from the chytrid fungus. Consequently, it is considered a species of conservation concern in Arizona. LLF is currently known to occur in mountain streams, ciénegas, and stock tanks in southern Arizona and northern Mexico. It is likely extirpated in California and New Mexico. Stressors can include non-native species predation and competition, catastrophic flooding of mountain streams (particularly after forest fires), loss of surface water availability, and chytridiomycosis-induced population die offs. As of January 2019, LLF are currently known to occur in at least six sites on Pima County conservation lands: 1) Cienega Creek Natural Preserve, 2) Youtcy Canyon Spring (A7 Ranch), 3) Espiritu Canyon (A7 Ranch), 4) Buehman Canyon (Buehman Canyon Preserve, Tesoro Nueve Ranch, and A7 Ranch), 5) Bullock Canyon (Buehman Canyon Preserve) and 6) Edgar Canyon (Six Bar Ranch and M Diamond Ranch). Cienega Creek is a lower elevation

intermittent, perennial stream in the Santa Cruz River watershed, while all other known sites are streams in higher elevation mountain canyons in the San Pedro River watershed. Lowland leopard frogs (apparently introduced and from a lower San Pedro River lineage) also occur, and are breeding in three small well-fed ponds at Catalina Regional Park, on the northwest side of the Santa Catalina Mountains. Frogs at this site are not included in Pima County's list of sites to be monitored.

Pima County's leopard frog monitoring objective is to detect biologically meaningful changes in the distributions of frog populations and where possible, to support other monitoring efforts at spatial scales beyond Pima County lands. Pima County has long invested resources in assessing and managing these frog species well before the finalization of the MSCP in 2016. For example, Pima County staff have been inventorying LLF occurrence during annual wet-dry mapping efforts across County preserve lands since 2011 (Powell 2018), and substantial amounts of time and resources have been put into restoring and creating habitat for CLF beginning in 2011. In 2014, Hospital Tank was pumped dry and nonnative and predatory green sunfish were removed from this site. Subsequent to the refilling of the tank, CLF from a nearby site on BLM land (Clyne Pond) recolonized this site in 2016. Nearby on Sands Ranch, Goat Well Pond was constructed in 2015-2016 and was reported as having been recolonized by CLF in April 2017. The six known LLF monitoring sites were inventoried regularly, however LLF were not detected during multiple years on several sites in the San Pedro River watershed, highlighting the sometimes-unpredictable small-scale patterns of occupancy of this species across the landscape.

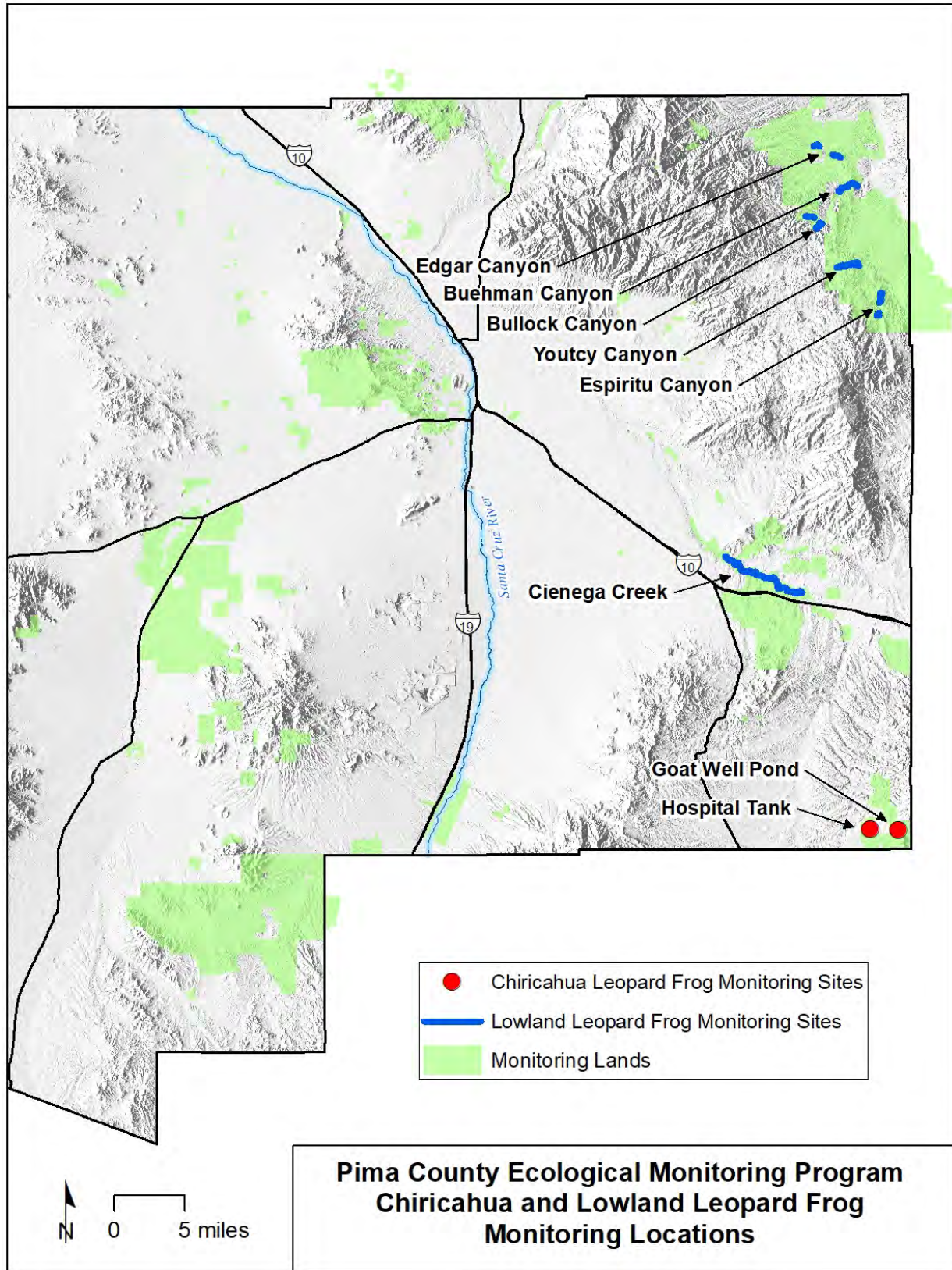


Figure 1. Map of Chiricahua and lowland leopard frog monitoring sites on Pima County Conservation Lands.

Monitoring Site Locations

Chiricahua Leopard Frog

Hospital Tank

Hospital Tank is an approximately 1.2 acre (when at 100% capacity) livestock tank on the County's Clyne Ranch. In 2011, the Pima County Natural Resources, Parks & Recreation (NRPR) department improved Hospital Tank on the Clyne Ranch, in part to improve potential CLF habitat. Herpetologist David Hall (University of Arizona) reported CLF having recolonized Hospital Tank as of September 2016. The tank is rainwater fed and fluctuates considerably in water level between wet and dry periods of the year (Figs. 2 & 3). When water levels are high, shrubby desert bankside vegetation can provide considerable cover for CLF; however, when water levels are low there is typically minimal above water vegetation to provide cover as a result of the broad exposed dirt bank. As many as 74 adult and juvenile CLF have been detected in a single survey (David Hall, personal communication), and CLF are reproducing at this site. Non-native American bullfrogs (*Lithobates catesbeianus*) have been a continuing management need on this site, and David Hall and his team of biologists have been leading efforts to regularly survey for and remove bullfrogs and their tadpoles as needed.



Figure 2. Hospital Tank on Clyne Ranch in early June when it is at its lowest point (June 2018).



Figure 3. Hospital Tank on Clyne Ranch in early fall after being filled by rainfall and runoff (October 2012).

Goat Well Pond

Goat Well Pond is an approximately 0.06 acre constructed pond in the County's Sands Ranch. The pond was constructed between 2015-2016 by Pima County NRPR staff and an Arizona Conservation Corps crew with funding from the USFWS's Partners for Fish and Wildlife Program. This site has permanent water supplied by a well (Figs. 4 & 5). Native riparian plant species were planted to create appropriate habitat for CLF. Additionally, this site is approximately 150 feet away from Goat Well Tank, an approximately 0.5 acre, rain-fed dirt tank. However, this tank does not hold permanent water. David Hall reported CLF present in Goat Well Pond in late April 2017, with as many as 20 adult CLF detected during subsequent nocturnal surveys in May of that year. As of January 2019, bullfrogs have not been detected in Goat Well Pond, although it remains a concern that this species could also colonize this pond.



Figure 4. Goat Well Pond on Sands Ranch in early December 2016.



Figure 5. Goat Well Pond on Sands Ranch in June 2018.

Lowland Leopard Frogs

Cienega Creek

Cienega Creek is a perennial stream located within the Cienega Creek Natural Preserve. Cienega Creek is classified as an Outstanding Arizona Water (ADEQ 2018) that includes extensive riparian habitat with high biodiversity. Cienega Creek drains the Empire and Whetstone Mountains through the Las Cienegas National Conservation Area before running through the County's Cienega Creek Natural Preserve lower in the watershed (Figs. 6 & 7). Cienega Creek represents one of the last perennial streams in southeastern Arizona and represents a key habitat and movement corridor for numerous protected species. The County and Pima Association of Governments (PAG) implement quarterly monitoring of surface water availability within the preserve. Monitoring efforts have shown long-term decreases in the linear extent of surface water in the creek, however some amount of surface water has always been present during monitoring at the driest time of year (i.e., June) and these stretches of perennial water, though fluctuating in extent from year to year, reliably occur in four disparate parts of Cienega Creek Preserve.



Figure 6. Pool below Del Lago diversion dam in Cienega Creek, Cienega Creek Natural Preserve.



Figure 7. Flowing reach of Cienega Creek, Cienega Creek Natural Preserve.

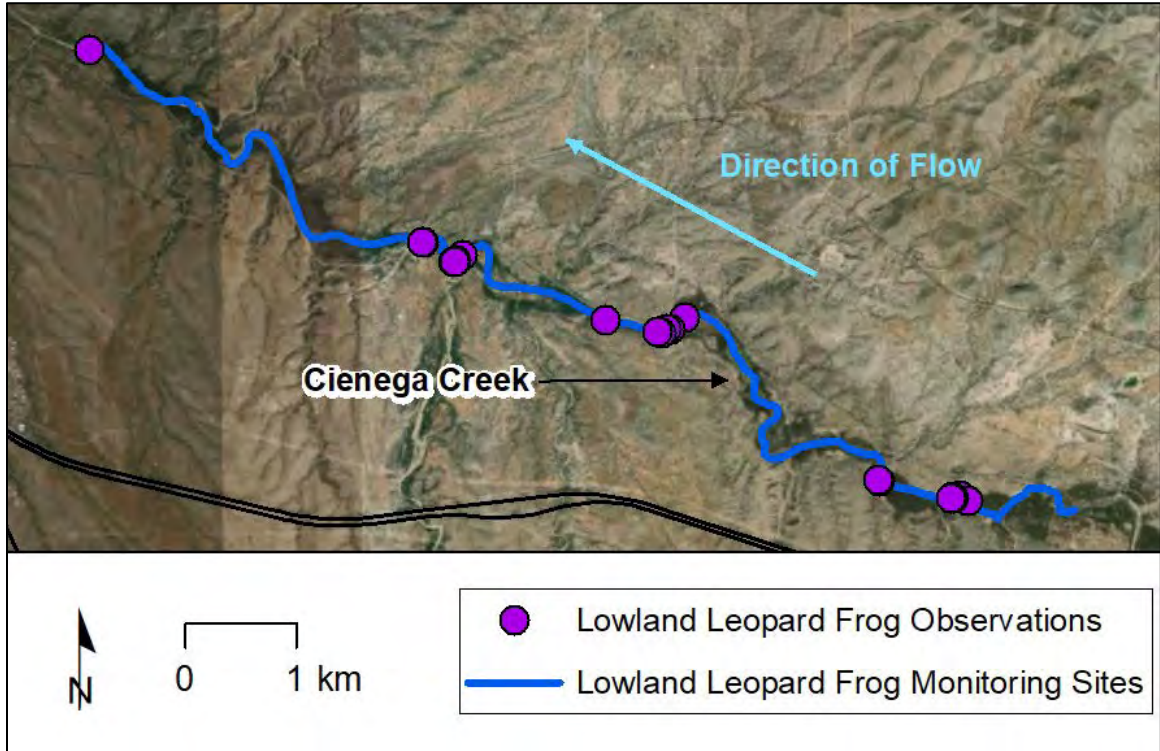


Figure 8. Cienega Creek monitoring site and all previous LLF observations made by County staff at this site.

Espiritu Canyon

Espiritu Canyon is located on the northeast side of the Rincon Mountains in the San Pedro River watershed on the County's A7 Ranch. Surface water flow is largely dependent on rainfall and snow melt in the upper portion of the watershed. This canyon is characterized by deep bedrock tinajas and fluctuating sediment flow, which can regularly change pool availability and depth. During wetter times of year surface water flow often connects these deeper pools, however during the pre-monsoon dry period (i.e., June) County staff have monitored two reaches (upper and lower) comprising approximately 2 km of suitable habitat. LLF have been found consistently in the lower reach (Figs. 9 & 10), but only intermittently in the upper reach with several individual frogs observed in one tinaja during fall of 2017.



Figure 9. Lower Espiritu Canyon on Pima County's A7 Ranch.



Figure 10. Lower Espiritu Canyon on Pima County's A7 Ranch.

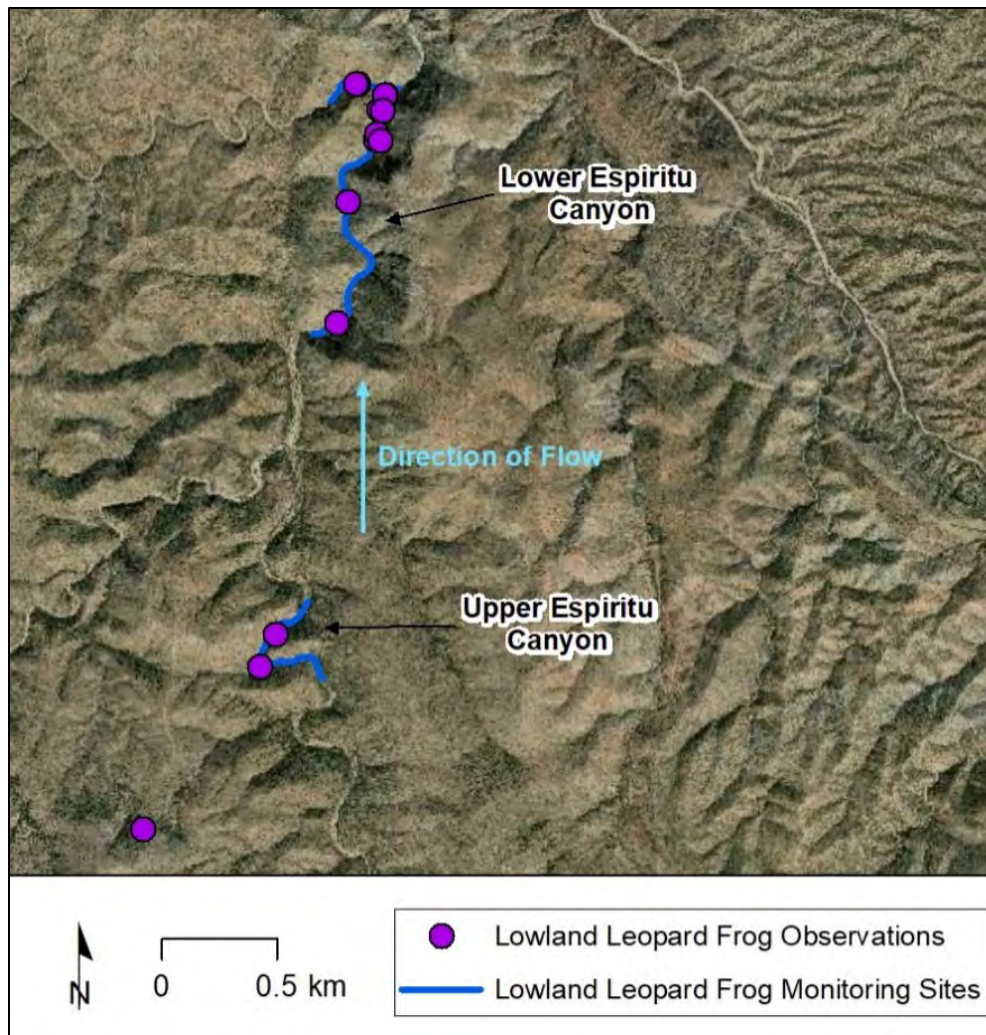


Figure 11. Upper and lower Espiritu Canyon monitoring reaches and all previous LLF observations made by County staff at this site.

Youtcy Canyon

Youtcy Canyon is located on the northeast side of the Rincon Mountains in the San Pedro River watershed on the County's A7 Ranch. Surface water flow in the canyon is spring-fed from Youtcy Canyon Spring, providing a reliable perennial water source. The canyon is characterized by several bedrock tinajas higher up in the canyon and longer more continuous pools below the spring source. Leopard frogs have been consistently observed in Youtcy Canyon below the spring since 2011 (Figs. 12 & 13); however impacts from livestock have occasionally occurred in this reach due to broken livestock fencing and in some years frogs were not detected at this site.



Figure 12. Youtcy Canyon Spring (July 2011).

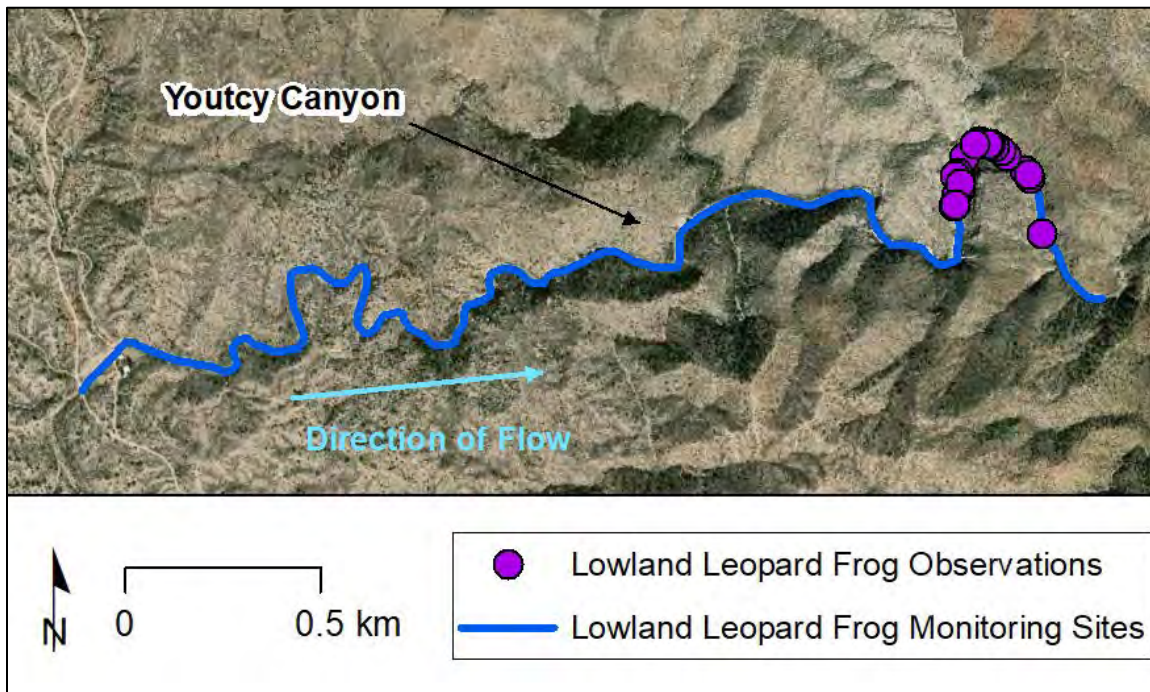


Figure 13. Youtcy Canyon monitoring site and all previous LLF observations made by County staff at this site.

Buehman Canyon

Buehman Canyon is located on the east side of the Santa Catalina Mountains in the San Pedro River watershed. Buehman Canyon is also classified as an OAW (ADEQ 2018). The canyon is characterized by numerous narrow wetted reaches as well as the largest spring-fed pool on the eastern slope of the Catalina range (Fig. 14). Much of the wetted reaches of Buehman Canyon occur on the Pima County Regional Flood Control District's Buehman Canyon Preserve and the County's Tesoro Nueve Ranch. Buehman canyon is divided into four wetted reaches: the upper, lower – upstream, lower – spring, and lower – tinajas reaches. Some parts of the lower reaches of Buehman Canyon also pass through the County's M Diamond and A7 Ranches. Leopard frogs have been consistently observed in the spring reach of lower Buehman Canyon, and this spring represents some of the best remaining riparian habitat in the surrounding area.



Figure 14. Lower Buehman Canyon (July 2011), Buehman Canyon Preserve.



Figure 15. Upper (March 2014) Buehman Canyon, Buehman Canyon Preserve.

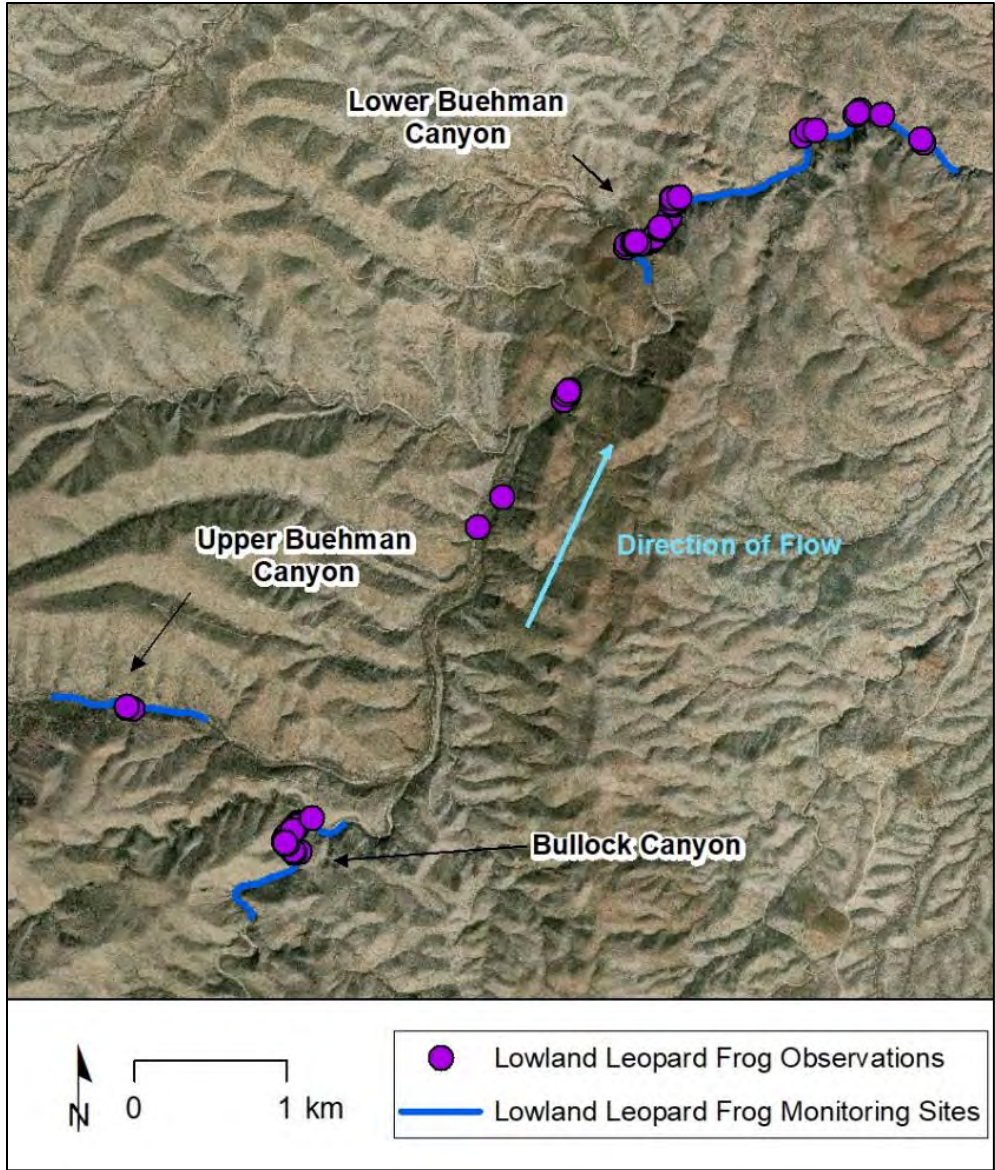


Figure 16. Upper and lower Buehman Canyon and Bullock Canyon monitoring reaches and all previous LLF observations made by County staff at these sites.

Bullock Canyon

Bullock Canyon is located on the east side of the Santa Catalina Mountains in the San Pedro River watershed and is a tributary to Buehman Canyon (Figs. 16 & 17). Part of this canyon, and most of the wetted riparian habitat, occur on the Pima County Regional Flood Control District’s Buehman Canyon Preserve.



Figure 17. Bullock Canyon (April 2008).

Edgar Canyon

Edgar Canyon is located on the east side of the Santa Catalina Mountains in the San Pedro River Watershed, north of Buehman Canyon, on the County's M Diamond and Six Bar Ranches. Lowland leopard frogs are periodically found occupying two cattle watering tanks in a portion of upper Edgar Canyon that is on Six Bar Ranch, but the majority of LLF occur in a wetted riparian stretch that is on M Diamond Ranch (Figs. 18 & 19).



Figure 18. Edgar Canyon (September 2012).

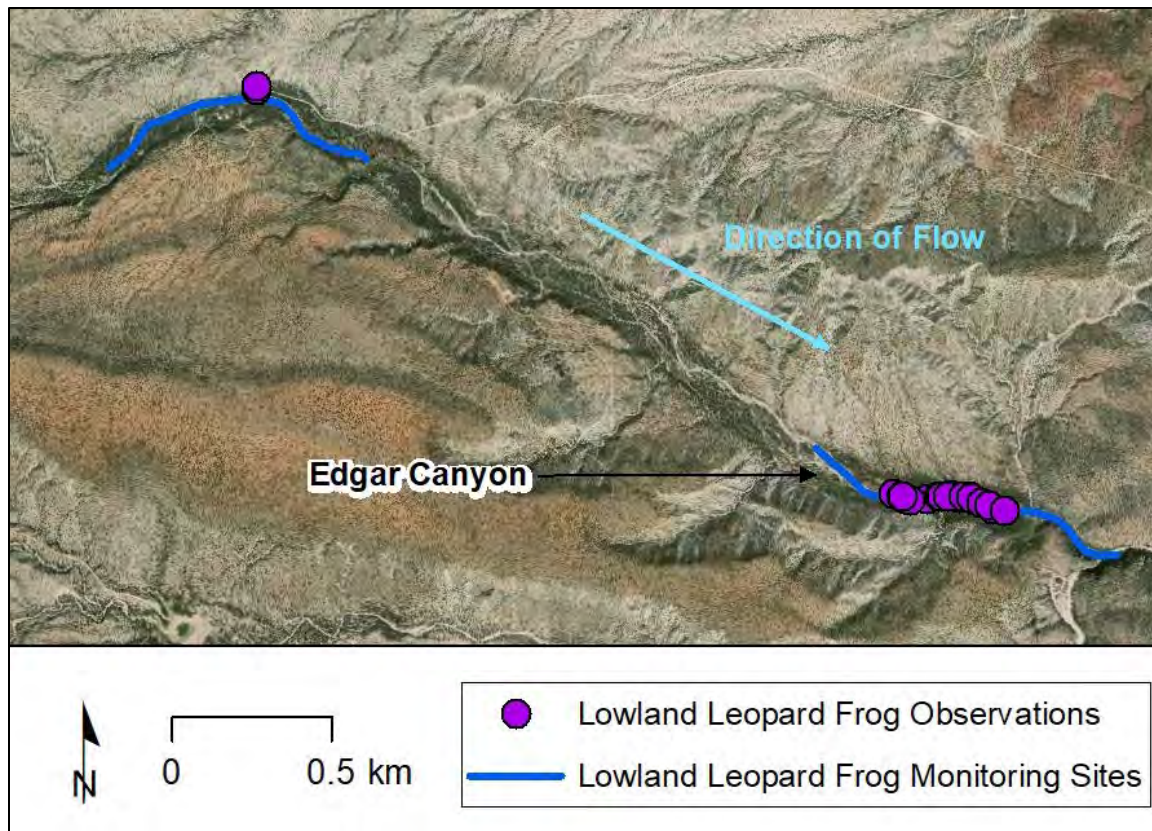


Figure 19. Edgar Canyon monitoring site and previous LLF observations made by County staff at this site.

Additional Sites

Lowland leopard frogs are also known to occasionally occur in other ephemeral livestock tanks as well as other springs within the watersheds of the above perennial streams. These tanks and springs are monitored on an ad-hoc basis as part of annual wet-dry mapping efforts. LLF detection at these sites has fluctuated based both on annual precipitation and the ephemeral nature of livestock tanks and generally includes only scattered observations of single frogs. These sites include a series of livestock tanks above Espiritu Canyon (Big, Upper, Youtcy Pasture and Jerry Tanks), Grapevine Spring above upper Espiritu Canyon, Peck Spring and associated tanks (M Diamond Ranch) and Davis Mesa Tank (Six Bar Ranch). Two livestock stocks that in the past had water from Peck Spring diverted into them contained a robust breeding population of LLF as recently as 2014, but the drying of these tanks has since eliminated frogs from this site. Geesaman Wash on the County's Oracle Ridge property used to hold small numbers of breeding LLF, but frogs were last noted here in 2011, likely due to a lack of surface water during subsequent years. All of the tanks listed here, and most others on County lands near LLF populations are supplied by runoff, and in dry years many of them are likely to be dry for part of the year, thereby limiting their potential for LLF establishment. County wet-dry mapping efforts include these other features as staffing and time allows, expanding the scope of aquatic habitat that is assessed for LLF occupancy. Pima County may become aware of populations of

LLF that are not included in the list of sites to be monitored through these or other efforts. The County will assess on a case-by-case basis whether to include any newly discovered LLF populations within its monitoring sample frame.

Field Survey Protocol

Chiricahua Leopard Frog

Pima County has agreed to monitor all reintroduced or naturally colonized populations of CLF every year for the first three years after establishment, followed by every three years thereafter. Surveys will be timed to coincide with annual pre-monsoon wet-dry mapping efforts in June. Staff will implement a diurnal visual encounter survey (Heyer 1994; USFWS 2007; https://www.fws.gov/southwest/es/arizona/Documents/SpeciesDocs/CLF/Final_CLF_Plan.pdf), and will consider a site to be occupied if an observation for any stage of the species' life cycle (eggs, tadpoles, adults) is confirmed. Surveys will also include an assessment of habitat conditions (water availability, vegetation condition) during each visit and the presence of threats (e.g., invasive species or adverse grazing). Frogs and/or tadpoles may be captured and handled, under permit, in order to determine species. Where possible, we will estimate the numbers of egg masses, tadpoles, juvenile, and adult frogs.

Staff will follow recommended guidelines which dictate that all field survey equipment be disinfected (i.e., 20% bleach solution, quaternary ammonium, and/or sunlight and drying for >24 hours) between surveys in order to prevent the potential spread of chytrid fungus or other pathogens, among CLF populations. Pima County staff maintain a hazard analysis and critical control point plan (HACCP) for ecological monitoring work in riparian habitats that is a part of its compliance with AZGFD and this rubric guides efforts to minimize the spread of pathogens.

While conducting surveys for Chiricahua leopard frogs (and lowland leopard frogs), Pima County will also note the presence of other aquatic species such as the Sonoran mud turtle and canyon treefrog, as well as nonnative invasive species such as American bullfrogs, sunfish, and crayfish. Pima County will investigate any sightings of Chiricahua leopard frogs on other preserve lands and, if presence is confirmed, Pima County will follow through with its above mentioned monitoring schedule.

Lowland Leopard Frog

Pima County has agreed to monitor occupancy of lowland leopard frogs at the six aforementioned sites every 3 years, beginning in 2018. Surveys will take place in the late spring and early summer, and will largely coincide with the wet-dry mapping inventory of riparian sites on County preserves during June. As part of wet-dry mapping, County staff assess many of these aquatic habitats more frequently than every three years, and during these status checks aquatic species presence, including of leopard frogs, is always noted. Occupancy will be for any

stage of the species' life cycle (eggs, tadpoles, adults) and employ a visual encounter survey method which is the same as for the Chiricahua leopard frog (see above). This monitoring protocol is primarily concerned with assessing leopard frog occupancy, but during site surveys we will estimate the numbers of tadpoles, juvenile, and adult frogs, where possible.

Particularly when moving along linear features, it is not difficult to reasonably estimate the number of juvenile and adult frogs, and in many places a specific area of aquatic habitat being examined is small enough that it is practical to closely estimate the numbers of frogs present. Additionally, where relevant, we will note the presence of different tadpole cohorts, as different developmental stages present in a single area may indicate multiple breeding events (i.e., small tadpoles without legs in the same pool as tadpoles with well-developed legs). Estimates of the numbers of tadpoles in a given area are less precise than those for frogs, and rather should be interpreted as a general barometer of the current status of LLF in a specific area.

As mentioned for CLF surveys, during lowland leopard frog surveys, Pima County will also note the presence of other aquatic species of interest, including invasive species. Pima County will investigate any sightings of the lowland leopard frogs on other preserve lands and, if presence is confirmed, Pima County may decide to pursue monitoring at that site.

Results

Chiricahua Leopard Frog

Table 1. Summary Chiricahua leopard frog monitoring results by site, 2018.

Site Name	Date Surveyed (Duration of Survey)	# Observed (by age class)*
Hospital Tank	23 May 2018 (N/A)	44 adults, 105 tadpoles (David Hall, personal comm.)
	8 June 2018 (33 min)	21 adult and juveniles, many tadpoles** (Pima Co staff)
Goat Well Pond	21 May 2018	21 adults (David Hall, personal communication)
	8 June 2018 (22 min)	3 adults, 3 potential adults, one egg mass (Pima Co staff)

*Numbers of tadpoles and juvenile leopard frogs are estimates.

** Tadpoles were not captured and some were likely bullfrog tadpoles.

Hospital Tank

We surveyed this site, on Pima County's Clyne Ranch, for 33 minutes on 8 June 2018. The edges of this earthen stock tank are mostly barren, with only sparse growth of Bermuda grass and forbs. There is no emergent aquatic vegetation, but there are large mats of the algae *Chara* sp. along much of this tank's aquatic shoreline. Nonnative mosquitofish remain abundant in this tank.

We observed 21 adult and juvenile Chiricahua leopard frogs at this site, and heard one male calling repeatedly. We saw one adult frog that may have been a bullfrog, but we were unable to confirm this. We saw many large tadpoles surfacing in the muddy waters of the tank. Seining efforts by David Hall and his team at this site on two dates in May 2018 demonstrated that there were both Chiricahua leopard frog and bullfrog tadpoles at this site, with bullfrog tadpoles numerically dominant (about 2.5 – 3 times more abundant) over Chiricahua leopard frogs (David Hall, personal communication). We did not capture any tadpoles, but it is likely we saw both species.

Goat Well Pond

We surveyed this site for 22 minutes on 8 June 2018. This is a small pond constructed with a liner. The water is moderately clear and about 40% of the pond's surface was covered with algal mats. Emergent vegetation includes some dense patches of cattails and sedges, primarily in submerged pots, as well as abundant shoreline vegetation. We saw many dragonfly nymphs. The pond is partially shaded by mesquite and netleaf hackberry. David Hall and his team from the University of Arizona first reported this site (built in 2016) as being occupied by adult Chiricahua leopard frogs in April of 2018. Subsequent nocturnal surveys in May revealed a maximum of 21 adult CLF at this site (David Hall, personal communication). We confirmed four adult CLF here on 8 June, including one very large female and two calling males. We also photographed one CLF egg mass in this pond. We caught brief glimpses of another five adult frogs that were also likely CLF, though we were unable to confirm that (However, bullfrogs have not been observed at this site.).

Lowland Leopard Frog

Table 2. Summary lowland leopard frog monitoring results by site, 2018.

Site Name	Reach (Length)	Date Surveyed (Time of Survey)	# Observed (by age class)*
Cienega Creek	12.9 km**	23 March 2018 5 June 2018 18 September 2018 17 December 2018	March: 1 adult June: unidentified frog tadpoles in 3 stretches; 1 unidentified adult/juvenile*** September: 4 adult/juveniles in 3 different stretches December: ~120 tadpoles in one pool
Buehman Canyon	Upper (2.02 km)	12 June 2018 (42 min)	None
	Lower – upstream (3.03 km)	12 June 2018 (47 min)	200 tadpoles
	Lower – spring (1.24 km)	12 June 2018 (39 min)	110 juvenile, 905 tadpoles
	Lower – tinajas (1.9 km)	12 June 2018 (123 min)	28 juvenile, 253 tadpoles
Bullock Canyon	(1.5 km)	12 June 2018 (117 min)	60-100 juvenile, 150-200 tadpoles
Edgar Canyon	(0.5 km)	13 June 2018 (51 min)	1 adult, 86 juveniles, 420 tadpoles
Espiritu Canyon	Upper (3.8 km)	7 June 2018 (120 min)	None
	Lower (1.83 km)	7 June 2018 (136 min)	2 juvenile, 250 tadpoles
Youtcy Canyon	Spring (1.08 km)	12 June 2018 (94 min)	10 adult, 220 juvenile, 1,050 tadpoles

*Numbers of tadpoles and juvenile leopard frogs are estimates.

**The length of stream that is monitored during quarterly wet-dry mapping efforts.

***A number of unidentified ranid frog tadpole observations were recorded, while they were not confirmed to be lowland leopard frog tadpoles, bullfrogs are not known to be currently reproducing in the creek channel and given the approximate tadpole size and the confirmed leopard frog tadpoles in nearby or similar sites by PCEMP surveyors, these observations are likely of LLF.

Cienega Creek Natural Preserve

Pima Association of Governments (PAG) coordinates quarterly monitoring of the extent of surface water in Cienega Creek Natural Preserve in March, June, September, and December. Pima County staff also contribute to this field effort, and a varying combination of staff and volunteers make up each of the quarterly walk-through teams. Approximately 12.9 km of Cienega Creek (spanning most of the width of the preserve) is traversed during each monitoring session. Here, Cienega Creek is a perennially intermittent stream passing through both mesquite bosque as well as substantial areas of native broadleaf deciduous riparian forest made up of Fremont cottonwood, Goodding's willow, and velvet ash. During the hottest and driest time of year (June) there are typically four disparate sections of Cienega Creek within the preserve that hold water, with a combined linear extent of as little as 1.6 km (fluctuating annually depending on rainfall and shallow groundwater levels).

Together with PAG, we surveyed the entire 12.9 km stretch of Cienega Creek during 17 December 2018. We observed lowland leopard frogs in only one stretch, which was a large and recently scoured pool immediately upstream of the Del Lago diversion dam near the western end of the preserve. This deep pool was approximately 5 m deep and 20 m long, and held at least two cohorts of leopard frog tadpoles. Approximately 20 were around 3 cm long and about 100 were around 2 cm long. PAG staff and volunteers also surveyed this entire stretch of Cienega Creek in March, June, and September of 2018. On 18 September an adult lowland leopard frog was photographed in a different stretch of permanent water, near where Marsh Station Rd. crosses over the creek. Across the March, June, and September wet-dry mapping efforts, PAG and their volunteers made at least 8 other observations of ranid frog tadpoles and unidentified frogs. We were not able to confirm the identity of these tadpoles and frogs (i.e., bullfrogs versus leopard frogs), but in recent years bullfrogs have not been known to reproduce in this part of the Cienega Creek main channel. Indeed, the flood and scour-prone nature of this riparian habitat does not lend itself to bullfrog reproduction, though adult and juvenile bullfrogs are seen on occasion in the main channel, likely dispersing into the creek from nearby ponds. It is likely that many of these ranid frog tadpole sightings were of lowland leopard frogs, and these unconfirmed observations occurred in all four of the preserve's stretches of permanent water. We also have one confirmed observation taken in 2018 of a juvenile bullfrog in Cienega Creek, near the Del Lago Diversion Dam. We assume that this individual dispersed here from the nearby golf course or other pond.

Buehman Canyon

Upper Buehman Canyon

We surveyed this 2.02 km stretch of Buehman Canyon on 12 June 2018 in 42 minutes. The entire stretch was dry except for an approximately 1.5 m long and 1.8 m wide (10 cm deep) pool at the spring which is located near the upper-most reaches of the surveyed stretch. The pool was shallow and muddied by cattle and other animals. We did not see any sign of lowland leopard frogs in this stretch. Lowland leopard frogs were observed at this spring-fed pool in the spring of 2016, and unknown tadpoles, possibly leopard frog, were noted in this same pool in June of 2017. Nonnative plants observed in this stretch included annual rabbitsfoot grass and oatgrass.

Lower Buehman Canyon – upstream reach

We divided lower Buehman Canyon into three reaches, and this is the upstream-most section where we surveyed about 3.03 km on 12 June 2018. This stretch primarily contained intermittent pools and the longest continuous wet stretch was about 47 m, with a very slight amount of flow. We observed approximately 200 lowland leopard frog tadpoles in this reach, as well as one juvenile leopard frog. There were also adult longfin dace (~200 dace) in parts of this stretch.

Lower Buehman Canyon – spring stretch

This stretch of lower Buehman Canyon extends from just upstream of the spring on the Tesoro Nueve Ranch property, downstream until Buehman Canyon crosses into Pima County's A7 Ranch. We surveyed this 1.24 km stretch in 39 minutes. This reach is a combination of intermittent pools as well as flowing and continuous stretches. The longest continually wetted reach was about 110 m and contained visible flow. Most of this stretch is shaded by a canopy of broadleaf deciduous trees, such as Arizona sycamore, Fremont cottonwood, velvet ash, and Goodding's willow. A small spring occurs up a short tributary of Buehman on the downstream side of the large, spring-fed pool pictured in Figure 20. This spring, Carpenter Spring, is more of a seep with some scattered small pools, and does not contain deeper pool habitat occupied by fish or leopard frogs.

We observed one adult lowland leopard frog, approximately 110 juvenile leopard frogs, and approximately 905 larval lowland leopard frogs. Small numbers of canyon treefrog tadpoles were noted, and large numbers of longfin dace (> 3000) observed throughout this reach. There are no bullfrogs or nonnative fish at this site. In the past, goldfish had occurred at this site, but are no longer there, presumably being wiped out by episodic flood scour.

Lower Buehman Canyon – tinajas stretch

This stretch of Buehman Canyon starts (on the upstream end) where Buehman Canyon crosses into A7 Ranch as well as including a small portion of M Diamond Ranch. Shortly thereafter, on the downstream side, Buehman Canyon opens up into a broad and sandy wash that does not contain permanent aquatic habitat. This lower-most reach of Buehman Canyon is largely a series of intermittent tinajas with no surface flow during our survey on 12 June 2018. Particularly the more downstream parts of this survey reach have little to no overhead canopy as the canyon becomes narrow and cuts through exposed bedrock. The largest tinaja was approximately 15 m long and 6 m wide, with water up to about 1.2 m deep (See Figure 21). Many of the tinajas were murky and clouded with algae, and appeared to be stagnant, and possibly anoxic. One drying pool contained large numbers of already dead Lowland leopard frog tadpoles.

In this stretch we observed 28 juvenile lowland leopard frogs, approximately 253 leopard frog tadpoles, and longfin dace in several of the larger pools (approximately 250 dace). Canyon treefrogs and treefrog tadpoles were also observed. This site had no nonnative fish or bullfrogs.



Figure 20. Large spring-fed pool on the part of Buehman Canyon that occurs on Tesoro Nueve Ranch. This is part of Buehman Canyon with the best and most permanent aquatic habitat that anchors large numbers of longfin dace and lowland leopard frogs.



Figure 21. Large tinaja in the downstream part of Buehman Canyon.

Edgar Canyon

We completed a 51 minute visual survey of this site on 13 June 2018. This is a stretch of aquatic habitat that is largely intermittent pools, with one portion containing a very light flow of surface water. All of the aquatic habitat is within an approximately 500 m stretch of the canyon. The largest continuous stretch of wetted habitat here was about 12 m long and 1.5 m wide. Depths were generally shallow, with the deepest pool being 0.7 m. Pool bottoms were largely sandy or in some places bedrock. We observed one adult lowland leopard frog, 86 juveniles, and approximately 420 tadpoles during this survey. This site contains no fish or bullfrogs.

Espiritu Canyon

Upper Espiritu Canyon

On 7 June 2018 we completed a visual survey of this site that included searching along about 3.8 km of canyon bottom. There were only three tinajas that held water, the largest being about 6 m long and 2.5 m wide, and the deepest being about 0.5 m deep. We did not observe any lowland leopard frog tadpoles in this stretch. During November 2017 field staff had reported several adult lowland leopard frogs in a deep tinaja in this stretch, but this pool was completely filled with sediment during this survey. There are no fish or bullfrogs in this stretch.

Lower Espiritu Canyon

On 7 June 2018 we completed a visual survey of this site. We canvassed a stretch of about 1.83 km of canyon over 136 minutes, including an unnamed tributary that contained multiple tinajas. We observed nonnative annual rabbitsfoot grass as well as fountain grass. Other than the unoccupied pools in the tributary (during November of 2017 several lowland leopard frog adults or large juveniles were observed in tinajas in this same stretch), there were only several isolated pools in lower Espiritu that had water. Substantial amounts of drying had occurred as evidenced by many decaying exposed algal mats. The largest of these was approximately 4.5 m long and 1.8 m wide and about 0.8 m at its deepest (Fig. 22).

This and a small satellite pool were the only part of lower Espiritu that we confirmed occupancy by lowland leopard frogs during an 18 minute visual inspection. We saw two leopard frog metamorphs in the satellite pool and about 250 leopard frog tadpoles in the large pool. Some of these tadpoles had hind limbs, and most were of similar size. We noted canyon treefrog tadpoles in the same stretch, but not in the same pool as the leopard frogs. We saw many resting adult canyon treefrogs on various rock faces in the canyon bottom. This site contains no fish or bullfrogs.



Figure 22. Intermittent pool in lower Espiritu Canyon with lowland leopard frog tadpoles.

Youtcy Canyon

We completed a 94 minute visual survey of Youtcy Canyon on 12 June 2018, covering about 1.08 km of canyon bottom. This site is a combination of intermittent pools and stream reaches, some with visible surface flow. The largest pool was about 4.5 m long and 0.8 m deep. The longest continuous stretch of water was about 163 m long and had visible flow in some parts. Reported numbers of juvenile lowland leopard frogs and tadpoles are estimates. Leopard frogs were much more abundant and occurred in a greater portion of available habitat relative to what has been observed in some past years. We saw multiple cohorts of tadpoles, from tadpoles that were < 2.5 cm long all the way to tadpoles that were in the process of metamorphosing into frogs. Relative to pools closer to the spring source, aquatic habitat in the more downstream stretches was more intermittent and showed signs of recent rapid drying (i.e., dried algae and stained gravel/rock around pool edges). The pool that was the furthest downstream contained large numbers of leopard frog tadpoles, but was isolated and rapidly drying. It is unlikely that these tadpoles would have survived.

We observed 10 adult lowland leopard frogs, approximately 220 juvenile leopard frogs, and about 1,050 leopard frog tadpoles. We also saw small numbers of canyon treefrog tadpoles. We saw signs of heavy cattle grazing in parts of the riparian area, including a herd of cattle in the downstream section. This site contains no fish or bullfrogs. There are nonnative and invasive plants at this site, including annual rabbitsfoot grass (*Polypogon monspeliensis*) and some extensive mats of Bermuda grass.

Bullock Canyon

On 12 June 2018 we surveyed this site that included traversing 1.5 km of Bullock Canyon, starting from its confluence with Buehman Canyon (survey time of 1 hour and 57 minutes). About 260 m of this canyon contained aquatic habitat, including the source of a spring located in this stretch that is situated on or near County land adjacent to the southernmost extent of this property that encompasses Bullock Canyon. The aquatic habitat includes two reaches of surface water with discernible flow in some places, as well as one large pool that is not continuous with either of the stretches of flow. This pool is associated with a concrete dam across the canyon (Fig. 23). One of the reaches with flow is above this pool, and the other is downstream of this pool (i.e., downstream of the dam). Parts of the upstream reach, near the property line, have a broadleaf deciduous canopy of velvet ash, Arizona sycamore, Goodding's willow, and Arizona walnut. Most of the rest of the aquatic habitat downstream has very little canopy cover, and is narrow and rocky in places. Here, there are scattered individuals of Goodding's willow and velvet ash, as well as seep willow and small patches of cattail and monkey flower.

We observed about 50-100 juvenile and 50-100 larval lowland leopard frogs distributed throughout the upstream reach of surface flow. The isolated and deep pool that is just upstream of the cement dam contained 10 juvenile, > 100 larval, and one adult lowland leopard frog. Many of the tadpoles were in the processing of metamorphosing. We did not observe any leopard frogs or tadpoles in the second reach of surface water, downstream of the dam.

We observed at least five longfin dace in the stretch of flow downstream of the cement dam. We did not see any fish in the pool or the second stretch of surface water that are both upstream of the dam. We have been observing longfin dace every year in pools below the dam since 2011 (although this site was not evaluated in 2012 and 2013), but have never observed them upstream of the dam. This feature is likely a barrier for the dace, and prevents them from accessing deeper and more continuous habitat upstream. We did not see any bullfrogs in Bullock Canyon, or other species of fish, and saw no signs of cattle grazing in the area. There are scattered patches of nonnative annual rabbitsfoot grass throughout the riparian habitat.



Figure 23. Large pool in Bullock Canyon, with cement dam visible in the background.

2018 Monitoring Season Summary

The 2018 monitoring season was a successful one for monitoring leopard frog populations on County conservation lands. CLF naturally established at Goat Well Pond and continued to reproduce, at Hospital Tank, thanks to the management efforts of NRPR staff and David Hall and his survey team. David Hall's dedicated bullfrog removal efforts are playing an important role in the suppression of this invasive species at Hospital Tank, and are likely positively contributing to the ability of CLF to successfully recruit at this site. County staff will survey both sites again in June of 2019.

Staff confirmed lowland leopard frog occupancy at all six permanent monitoring sites in 2018. Within those sites, we did not detect LLF in two of nine distinct reaches; however both channel morphology and detection in those sites are known to be dynamic. Winter and spring rainfall allowed for large amounts of sediment transport in these systems, and reaches such as upper Espiritu Canyon lost much suitable habitat through sedimentation of tinajas (including the only tinaja that LLF were observed in during 2017). In future LLF monitoring seasons, we plan to participate more actively in the PAG Cienega Creek June surveys to maintain consistency in

sampling time across all sites. Lastly, staff implement wet-dry mapping annually in many of these systems and will continue to collect ad-hoc LLF observations in tandem with these other monitoring efforts adding considerable scope and frequency to gain insight into the occupancy dynamics of this species.

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Appendix A

Date: ___/___/_____
 M M D D Y Y Y Y

RACH/Riparian Herpetofauna

NUM: _____ - _____

VES Datasheet

Arizona Game and Fish Department

Last updated April 2017 version 2.1.1

SITE:				SITE AT: (Additional location info)			
Observer(s):		Affiliation:		Email:		Phone:	
Time (24Hr) Start:		Stop:		Dry Site:		Y N	
ST-CNTY:		UTM ZONE (Circle one)		NAD (Circle one)		<i>Lotic sites use both start and stop</i>	
___ - _____		11 12 13		83		UTM Start:	
System Type: (circle one)		27		UTM Stop:		_____	
Lentic Lotic		Water Source:		Spring Runoff Well Unknown			
		Water Type:		Wetland Earthen tank Reservoir Artificial structure			
Surface Area (must be measured) <i>Lotic sites use width measurement</i>				VOUCHERS Habitat Photos: Y N Specimen Photos: Y N			
Length (m):		Width (m):		Specimen(s) collected: Y N			
				# of Disease/Genetic Samples: Water _____ Swab/Tissue _____			
T_{Air}: °C °F		T_{Water}: °C °F		RH: %		Precipitation: (circle one) None Intermittent Steady	
						Wind: Still Breezy Windy	
Search Methods:		Visual Seine Trap Dipnet Snorkel Boat Call Playback					
Vegetation	%	Prominent Species (if known)				PREDATORS (Non-Herp)*	
Floating						Native fish Nonnative fish	
Submerged						Crayfish Birds	
Emergent						Aquatic invertebrates Mammals	
Perimeter						Grazing Enclosure: Y N Partial	
GRAZING ACTIVITY		Livestock: Animal Present Sign		Native Ungulate: Animal Present Sign			
SITE/SURVEY NOTES: (*include any predator species from above)							
----- RIPARIAN HERPETOFAUNA (circle one life stage per line) -----							
Species	Certainty	Life Stage				Total #	Comments (calling, breeding, behavior, etc):
	Uncertain Certain	Egg	Larvae	Juvenile	Adult		
	Uncertain Certain	Egg	Larvae	Juvenile	Adult		
	Uncertain Certain	Egg	Larvae	Juvenile	Adult		
	Uncertain Certain	Egg	Larvae	Juvenile	Adult		
	Uncertain Certain	Egg	Larvae	Juvenile	Adult		
	Uncertain Certain	Egg	Larvae	Juvenile	Adult		

RACH Release (circle one) Y N

CONDENSED INSTRUCTIONS for RACH / Riparian Herp VES Datasheet (Last updated: April 2017)

Review the COMPLETE INSTRUCTIONS for RACH / Riparian Herp VES Datasheet before filling out the datasheet. These CONDENSED INSTRUCTIONS are only for field reference.

LOCALITY AND VISIT DATA

- Num:** This field is used for central data management purposes. A site number is a unique code consisting of 3-letters describing the land manager and a 4-digit number assigned in ascending consecutive order within each management unit (e.g. TON-0001). NGB Herps survey personnel may enter the management unit code (See COMPLETE INSTRUCTIONS for list of management unit codes).
- Site:** A site is >1 mile from any other survey locality, or represents a distinct change in habitat types. Record site name as it is marked on the quad or land management map. If unnamed, write "unnamed" preceding the type of feature. If not marked on any map, write "unmarked" preceding the type of feature.
- Site At:** Always complete for unnamed and unmarked sites and for large/long aquatic systems. For other sites, use as needed to enhance the name and pin-point location. Use features such as the nearest road crossing, stream confluence, or topographic feature.
- Observers:** People present during the survey. Record names as: first initial, period, second initial, period, full last name (e.g. M.J.Sredl).
- Time Start:** Time the surveyor(s) began searching for riparian herps using a 24-hour clock.
- Time Stop:** Time the surveyor(s) stopped searching for riparian herps using a 24-hour clock.
- Dry:** Circle "Y" or "N" to indicate whether the site was dry. This field explains why other Visit Conditions field may have no data.
- St-Cnty:** State abbreviation followed by a hyphen and first 4 letters of the county name (e.g. AZ-MARI) for the starting point of the survey.
- UTM Zone:** Zone in which the starting point of the survey occurs: zone 11 (W of 114° longitude) includes the extreme western portion of AZ, zone 12 (E of 114° longitude, W of 108° longitude) includes most of AZ and the western portion of NM, zone 13 (E of 108° longitude) includes the remainder of NM. Check the GPS unit setting.
- UTM Datum:** Circle the datum of the UTM coordinates. NAD83 is preferred.
- UTM Easting:** UTM Easting (6-digit number) for the starting point of the survey. Use a GPS unit to determine the UTM coordinates.
- UTM Northing:** UTM Northing (7-digit number) for the starting point of the survey. Use a GPS unit to determine the UTM coordinates.
- System Type:** Circle 1 hydrological class that best describes the water system of the site: Lentic = still water, Lotic = flowing water.
- Water Source:** Circle the source of water at the site, if not known leave blank.
- Water Type:** Circle 1 category that best describes the type of water at the site. Artificial structure would consist of cement or metal structure designed to hold water.
- Surface Area:** Length (i.e. long axis) and width (i.e., short axis) of the system in meters. For both length and width, measure the entire system (not just portion surveyed) using the standing water present at the time of the visit as the boundary. Width should be the maximum distance perpendicular to the length axis. Use a rangefinder or measuring tape, DO NOT ESTIMATE.
- Vouchers:** Record if specimen photo vouchers and habitat photos are taken at the site. Photo vouchers are close-ups of diagnostic characteristics. Circle "Y" or "N" to indicate whether voucher specimens were collected; record number of disease (water/swabs/tail clips) and genetic samples (swabs/tail/toe clips) collected. Include disposition of specimen in Site/Survey Notes, if known.
- T_{AIR}:** Air temperature 1.5 m above ground and 1.5 m from the water. Circle appropriate measurement unit. Celsius is preferred. Thermometer should be shaded and dry.
- T_{WATER}:** Water temperature 1 cm below water's surface and 1 m from shore (or at center). Circle appropriate measurement unit. Celsius is preferred. Thermometer should be shaded.
- RH:** Relative humidity (%) 1.5 m above ground and 1.5 m from water.
- Precipitation:** Circle 1 category that best describes precipitation.
- Wind:** Circle 1 category. Estimate wind speed 1.5 m above the ground and 1.5 m away from the water. Still <3mph; Breezy is between 3-12mph; Windy >12mph.
- Search Methods:** Circle all methods used to search for riparian herps.
- Vegetation:** Percent of area potentially inhabited by target species that is covered by floating vegetation, submerged vegetation, emergent vegetation, perimeter vegetation up to 1 m from water's edge. Use increments of 5%. Percents do not have to total 100. Write genus or common name (only if positive ID) of 1 - 4 most prominent species for each vegetation type.
- Predators:** Circle all non-herp predators seen/detected at the site. List species in Site/Survey Notes.
- Grazing Exclosure:** Circle 1 category indicating if the site has a partial exclosure, full exclosure, or no exclosure for the purposes of eliminating grazing pressure.
- Grazing Activity:** Circle if sign or animals are present at site. This is distinguished between native ungulates and/or feral or domestic livestock.
- Site/Survey Notes:** Use as needed to describe significant features of a site or survey. Do not be redundant with info in other fields. Write short, specific notes that emphasize habitat quality and why you think you did or did not observe riparian herps, such as land use at or near the site, or differences between the survey area and total area.

RIPARIAN HERP OBSERVATIONS

- Species:** Riparian herp species observed during the survey using their unique 4-letter Genus-Species code or the code corresponding to the taxonomic classification for which you are certain in your ID. Refer to "GenusSpecies codes for Arizona herpetofauna". These codes are primarily based on Brennan and Holycross 2006, although there is a great deal of overlap with Stebbins 2003. Do not use historic info to bias your decision on species ID. Enter your own most confident observation and justify it in the Comments field. If no riparian herps are observed, record "NONE".
- Certainty:** Circle 1 word to indicate your level of certainty regarding your ID of each species. Certainty of ID should be based on species-specific diagnostic characteristics.
- Life Stage:** Circle 1 category that best describes the life stage of each species. Juvenile leopard frog <55 mm SVL. Adult leopard frog >55 mm SVL or has signs of breeding condition (e.g. swollen thumbpads, stretched vocal sacs).
- Total #:** Number of individuals of each species/life stage observed. Do not estimate total numbers within survey area. For egg masses, enter number of masses and then use the Comments field to record overall size and condition of masses, and stage of embryos (refer to Gosner 1960).
- Comments:** Use as needed to record relevant comments regarding species & life stages observed. Types of comments to include are: 1) criteria used to identify species; 2) if species ID is uncertain, note observed physical features & behaviors that could be useful (e.g. no RACA peep heard, ranid-like plop); 3) presence of any observed disease or deformity.

Location	Property: _____ Site ID: _____
	Water class: Lentic / Lotic Water Type: Tinaja/Spring/Stock tank/Small metal or concrete tank/Stream/Seep
	New transect or site?: Y / N If "yes", use "New monitoring site" form

Visit	Date: ___/___/___ Observer(s): _____ Visit #: _____												
	Start time: _____ Stop time: _____ Total search time: _____												
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	Search Effort		total perimeter	Partial perimeter	left bank	right bank	Both banks		Search method: <input type="checkbox"/> dip net <input type="checkbox"/> seine <input type="checkbox"/> visual <input type="checkbox"/> hand exploration				
Photographs taken: Y / N If "yes", file number(s): _____													

Air Temp (°F): _____ Wind (Beaufort Scale): _____ Humidity(%): _____
Cloud cover (%): _____ Precipitation: none <input type="checkbox"/> intermittent <input type="checkbox"/> steady & light <input type="checkbox"/> steady / heavy <input type="checkbox"/>
Lentic length(m): _____ Lentic width(m): _____ Lotic width(m): _____ Lotic length(m): _____
Is the site dry? Y / N If "no" note: _____ Water temperature (°F): _____ DO (ppm): _____ pH: _____
Water clarity: extremely clear <input type="checkbox"/> moderately clear <input type="checkbox"/> extremely turbid <input type="checkbox"/>

Environment and habitat	Riparian width: 0-2m <input type="checkbox"/> 3-5m <input type="checkbox"/> 6-10m <input type="checkbox"/> 11-20m <input type="checkbox"/> 21-50m <input type="checkbox"/> >50m <input type="checkbox"/>	Primary Substrate: mud/silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobble <input type="checkbox"/> boulder <input type="checkbox"/>																							
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Plants: Giant reed/Ludwigia/Other <input type="checkbox"/>																									
Other Organisms: _____																									
Site/survey/environmental condition notes, including general info on plant species and coverage																									

Survey data	Species	Certainty	Life Stage	#	Notes
		uncertain certain	egg larvae juv adult		
		uncertain certain	egg larvae juv adult		
		uncertain certain	egg larvae juv adult		
		uncertain certain	egg larvae juv adult		
		uncertain certain	egg larvae juv adult		
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		uncertain certain	egg larvae juv adult		

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 11

Southwestern Willow Flycatcher Monitoring Protocol



Pima County Ecological Monitoring Program
Southwestern Willow Flycatcher Monitoring Protocol

January 2019



Prepared by Pima County Office of Sustainability and Conservation Staff:
Ian W. Murray
Jeff M. Gicklhorn

Recommended Citation:

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Abstract

The southwestern willow flycatcher is one of the species covered under Pima County's Endangered Species Act Section 10 permit and associated Multi-species Conservation Plan. Within the MSCP Pima County has agreed to monitor for the presence of southwestern willow flycatchers, using the U.S. Fish and Wildlife Service (USFWS) call playback survey protocol, in potential riparian habitat at Bingham Cienega Natural Preserve and Cienega Creek Natural Preserve. Pima County followed the 'general survey' iteration of the monitoring protocol that prescribes one survey during each of three survey periods. We did not detect any flycatchers at Cienega Creek, although there may be suitable habitat at that site. We also did not detect any flycatchers at Bingham Cienega, and there is no suitable habitat for this species at this time at this site. Consequently, in consultation with the USFWS, Pima County has been given approval to drop Bingham Cienega as a flycatcher monitoring site, pending any return of suitable habitat for flycatchers at this site. At least every three years, riparian habitat will be evaluated at Bingham Cienega to inform whether flycatcher monitoring should be resumed here.

Acknowledgements

We thank Jennie MacFarland, Jonathan Horst, and volunteers from the Tucson Audubon Society for their efforts in completing surveys. We also thank Iris Rodden for assistance in completing this fieldwork. Brian Powell also provided key insights, discussion, support, and assistance with fieldwork. Jennifer Becker and Jess Barry provided important logistical support and access to the Bingham Cienega site. We also thank Susan Sferra, Greg Beatty, and Scott Richardson for key discussions on survey placement and other logistics.

Background

Pima County's Multi-species Conservation Plan (MSCP) is tasked with ensuring that the County remains in compliance with its federal Endangered Species Act Section 10 Incidental Take Permit. Implementation of an ecological monitoring program is a key requirement of the MSCP, and Pima County has agreed to conduct species-level monitoring for 15 of the 44 plant and animal species covered under the MSCP. The endangered Southwestern willow flycatcher (SWFL) is one such species that the County has agreed to monitor on select riparian habitat across County preserve lands.

The Southwestern willow flycatcher (*Empidonax traillii extimus*) is one of four subspecies of the willow flycatcher. It was listed as an endangered species in 1995, primarily due to widespread loss and degradation of riparian habitats in the American Southwest. It is a neotropical migrant songbird that breeds in the southwestern United States and parts of Mexico, and winters primarily in parts of Mexico and Central America. This species is considered to be a riparian obligate, because it requires dense riparian vegetation within which to nest and the presence of surface water, or soil that is moist enough to support this dense vegetation. This riparian vegetation can be either native broadleaf plant species (i.e., willows, buttonbush, cottonwood, ash) or nonnative species such as tamarisk. Breeding habitat generally consists of a brushy and dense understory ($\geq 3\text{m}$ tall) with significant amounts of live foliage. SWFL will breed in dense understory that includes a taller canopy of larger trees (such as larger cottonwood and willows), but this is not a requirement as long as a dense and shrubby understory is present (Sogge et al. 2010).

Objectives

Pima County has committed itself to monitoring for the presence of this species using the USFWS-approved call playback survey protocol outlined in Sogge et al. (2010; <https://pubs.usgs.gov/tm/tm2a10/>). Pima County originally agreed to monitor for this species in three areas of the County's preserve lands that at one point were thought to contain suitable riparian habitat for the species (Pima County 2016). These areas include portions of the A7 Ranch adjacent to the San Pedro River, Bingham Cienega Natural Preserve, and Cienega Creek Natural Preserve. However, in the lead up to the County's first round of SWFL monitoring, inspection of aerial imagery and on-the-ground field assessments with USFWS staff concluded that at this time there is no potential SWFL breeding habitat on those parts of A7 Ranch near the San Pedro River and that it was appropriate to drop this site from those sites that Pima County has committed to monitor for SWFL. **Consequently, Pima County's SWFL monitoring commitments include assessing the occupancy of this species at Bingham Cienega Natural Preserve (one transect) and Cienega Creek Natural Preserve (two transects) following the Sogge et al. (2010) protocol.**

Methods

In 2017, Pima County used the Sogge et al. (2010) playback survey protocol to assess for the presence of the Southwestern willow flycatcher on two Pima County preserve properties, Bingham Cienega Natural Preserve and Cienega Creek Natural Preserve. We followed the 'general survey' iteration of the monitoring protocol that prescribes one survey visit completed during each of the three survey periods (May 15-31, June 1-24, and June 25 – July 17).

We used a FoxPro NX4 electronic caller (or similar device) loaded with a recording provided by the USFWS that contained a series of *fitz-bew* calls to survey for SWFL beginning at or near sunrise and occurring no later than about 1030 h. We followed a 10-30 second quiet listening period with ~15 seconds of broadcast, followed by a one minute listening period. We repeated this every 20-30 meters as we moved through the habitat to be surveyed. All lead field surveyors had completed the SWFL survey protocol training offered by the USFWS and the Arizona Game and Fish Department. See Sogge et al. (2010) for a complete description of the methodology that we followed.

Surveys on Cienega Creek Natural Preserve were done on four different stretches of creek, all of which had some permanent water during the surveys, with mostly native broad-leafed riparian woodland (e.g., Fremont cottonwood, velvet ash, Goodding's willow, and velvet mesquite) and a diverse shrub understory ranging from sparse to dense along the survey lengths (See Figures 1 & 2). Survey transects at Cienega Creek were linear and followed the course of the stream channel with the start and end points given in Table 1.

Riparian habitat quality at Bingham Cienega has declined precipitously over the recent past such that the cienega and downstream marshy habitat no longer have surface water, or even moist soil, during early summer. We surveyed sinuous transects in each of four discrete habitat patches which we concluded had the best potential habitat left on the property, as concluded by pre-survey field assessments (See Figure 3). Bingham Cienega is a historical flycatcher survey site but we do not have available the exact survey locations of previous surveys. Presumably, surveys were focused on the main cienega north of the Bingham ranch house (Figure 3; Cienega patch; ash/cottonwood/buttonbush woodland) as well as the brushy and wet outflow of this cienega. We report the locations of the points bounding the survey polygons (taken from the greatest dimension) in Table 2. During surveys of these polygons, surveyors walked irregularly shaped routes in order to best cover all of the habitat, thus reported distances are minimum estimates of distance covered.

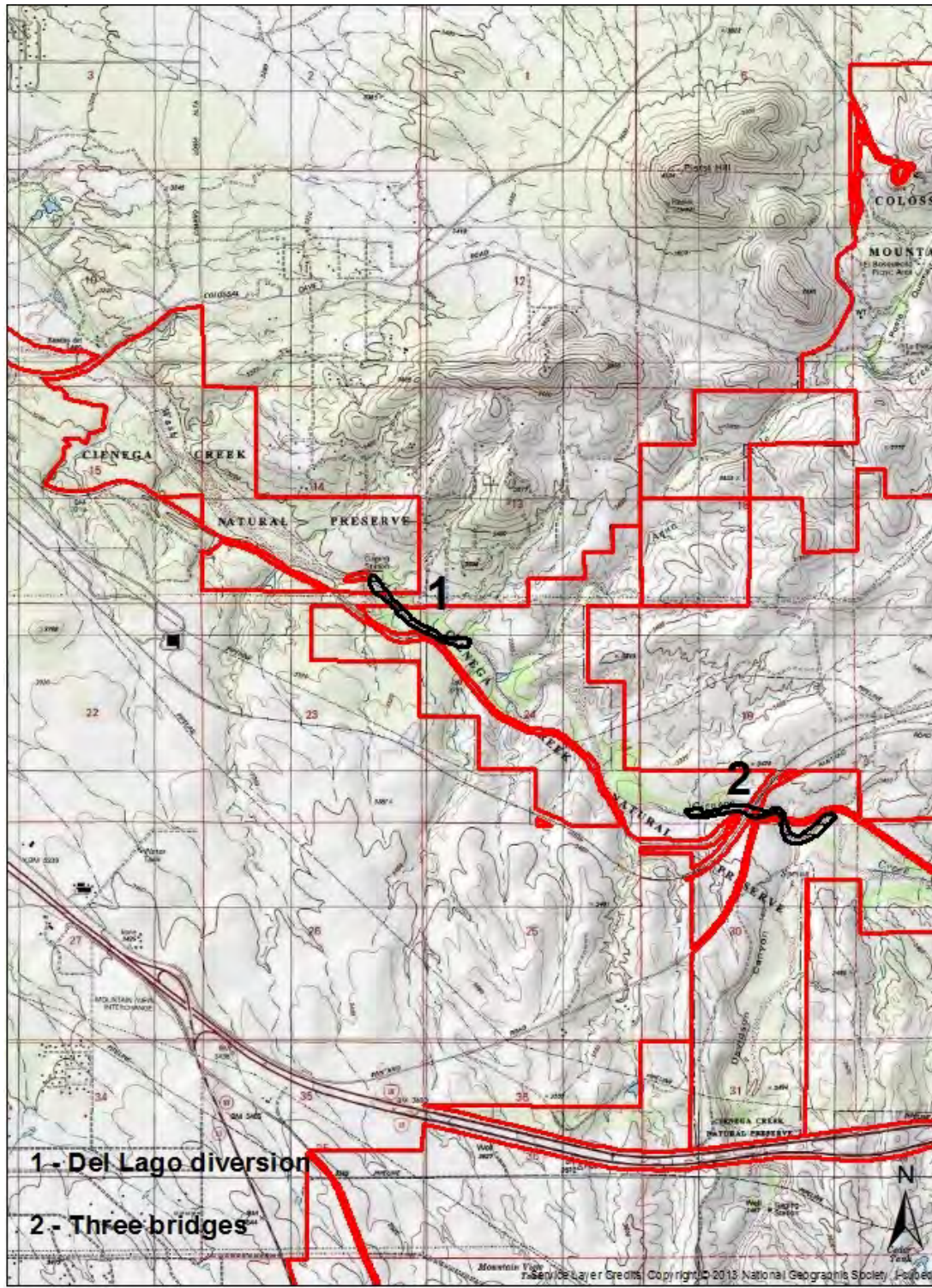


Figure 1. Survey transects for Southwestern willow flycatcher in the west section of Cienega Creek Natural Preserve.

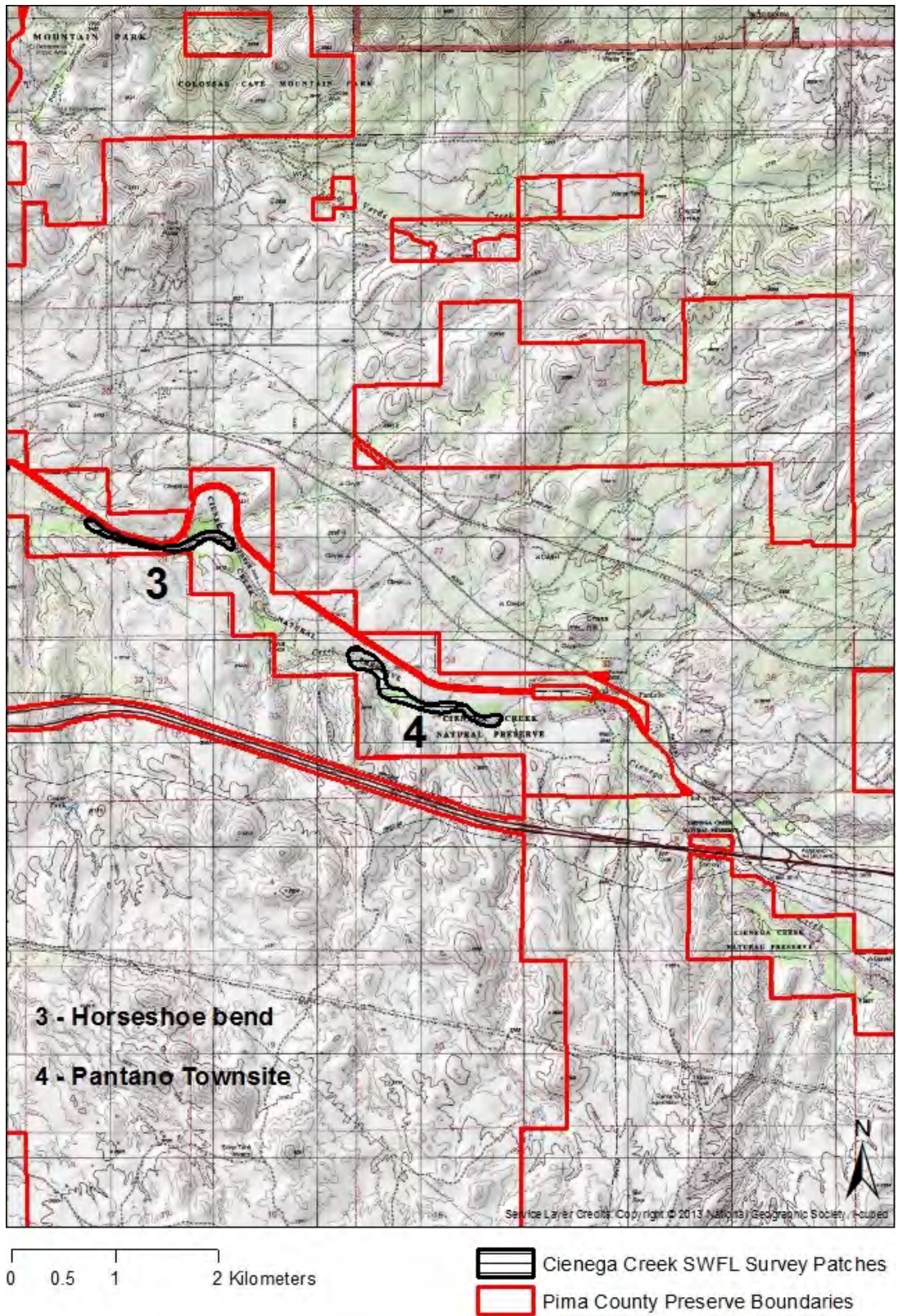
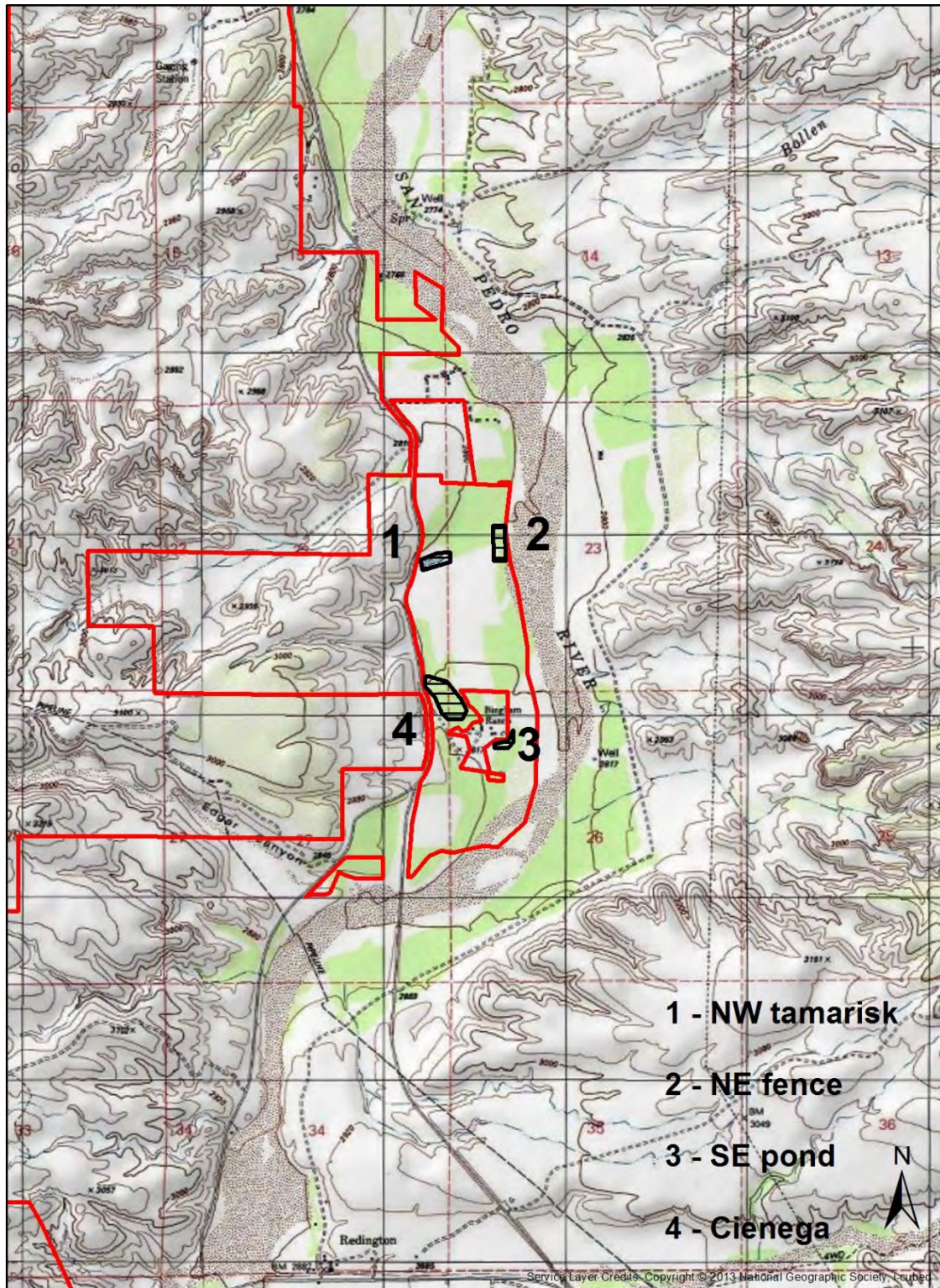


Figure 2. Survey transects for Southwestern willow flycatcher in the east section of Cienega Creek Natural Preserve.



0 0.5 1 2 Kilometers Bingham Cienega SWFL Survey Patch
 Pima County Preserve Boundaries

Figure 3. Survey transects for Southwestern willow flycatcher at Bingham Cienega Natural Preserve.

Results

We surveyed approximately 0.8 km (estimated maximum extent of all the survey patches) of area at Bingham Cienega and 5.6 km (linear distance of stream channel) at Cienega Creek, a total of three times each during the three survey periods (Tables 1 & 2). We did not detect any SWFL on any of the survey visits. See Appendices I and II for other incidental bird species detected at these sites during surveys.

Table 1. Location of Pima County southwestern willow flycatcher survey transects (2017). UTM's are given in the datum NAD83.

Site	Survey Start		Survey End	
	UTM Easting	UTM Northing	UTM Easting	UTM Northing
Cienega Creek Natural Preserve*				
Del Lago	531289	3543957	530583	3544429
3 Bridges	534053	3542590	533006	3542669
Horseshoe	536344	3541669	534692	3542190
Pantano	538593	3540219	537325	3540792
Bingham Cienega Natural Preserve**				
NW tamarisk	548367	3591883	548222	3591852
NE fence	548613	3591873	548618	3592070
Cienega	548424	3591006	548279	3591322
SE Pond	548715	3590917	548695	3590808

*Locations provided are the start and end points of linear transects following the stream channel.

**Locations provided are the points marking the greatest dimension of a survey polygon.

Table 2. Summary survey results for Pima County southwestern willow flycatcher monitoring (2017).

Site	Survey Period 1 May 15 - 31		Survey Period 2 June 1 - 24		Survey Period 3 June 25 – July 17	
	Area length (km) Survey time (h)	SWFL	Area length (km) Survey time (h)	SWFL	Area length (km) Survey time (h)	SWFL
Bingham Cienega Natural Preserve						
NW tamarisk	0.2 km; 0.5 h	0	0.2 km; 0.5 h	0	0.2 km; 0.8 h	0
NE fence	0.2 km; 0.4 h	0	0.2 km; 0.5 h	0	0.2 km; 0.3 h	0
Cienega	0.3 km; 0.9 h	0	0.3 km; 1.5 h	0	0.3 km; 0.5 h	0
SE Pond	0.1 km; 0.2 h	0	0.1 km; 0.3 h	0	0.1 km; 0.5 h	0
Cienega Creek Natural Preserve						
Del Lago	1.0 km; 1.2 h	0	1.0 km; 1.0 h	0	1.0 km; 1.4 h	0
3 Bridges	1.3 km; 1.0 h	0	1.3 km; 0.6 h	0	1.3 km; 1.5 h	0
Horseshoe	1.6 km; 2.0 h	0	1.6 km; 2.0 h	0	1.6 km; 1.3 h	0
Pantano	1.7 km; 1.3 h	0	1.7 km; 1.3 h	0	1.7 km; 2.0 h	0

Cienega Creek Natural Preserve

The four reaches of Cienega Creek that we surveyed all contained surface water or moist soil. We frequently observed other riparian bird species such as common yellowthroat, yellow-breasted chat, and yellow warbler, and riparian obligate species such as longfin dace and lowland leopard frogs were also present. The surveyed stretches were primarily native broadleaf plants (> 90%) and generally had a 12 – 15 m high canopy (where present) of Goodding's willow, Fremont cottonwood, and velvet ash. Tamarisk, though present, was widely scattered and relatively rare. The native shrub understory in the areas that we surveyed ranged from sparse (Figure 4) to dense (Figure 5).



Figure 4. Survey stretch with a well-developed canopy of cottonwood, velvet ash, and Goodding's willow, but a relatively sparse understory of shrubby vegetation, at Cienega Creek Natural Preserve.



Figure 5. Survey stretch with a well-developed canopy of cottonwood, velvet ash, and Goodding’s willow, as well as a dense understory of herbaceous and shrubby native vegetation, at Cienega Creek Natural Preserve.

Bingham Cienega Natural Preserve

We surveyed four areas that contained the best potential SWFL habitat on the property. None of the survey areas contained moist soil, and the only surface water on the site is a small well-fed pond that is adjacent to the Bingham Cienega ranch house. This pond is on an inholding that is not part of the available surface area and while some willow and ash trees ring it (Figure 6), the adjacent habitat surveyed on County land is dry and primarily mesquite bosque with little understory development (SE Pond; Figure 3). There is a narrow, but dense area of tamarisk ringing a long-dried pond in the northwestern-most survey area (NW tamarisk; Figure 3). These salt cedars show visible signs of moisture stress with substantial die-off of large limbs (Figure 7). Much of the northeastern area that we surveyed (NE fence; Figure 3) is a mesquite bosque with an understory of graythorn and scattered netleaf hackberry trees (Figure 8). What used to be the main cienega and its outflow is completely dry, but still contains a canopy of velvet ash and cottonwood, with substantial levels of tree dieback. The understory lacks herbaceous vegetation, and is made up of scattered large buttonbush plants, as well as large amounts of downed woody debris (Figure 9).

In its current state of continuing riparian decline, Bingham Cienega is not likely to contain suitable SWFL breeding habitat.



Figure 6. Well-fed pond with narrow stringer of velvet ash, Goodding's willow, and other riparian broad-leaf tree species adjacent to survey area in the southeastern part of Bingham Cienega Natural Preserve. The adjacent area that was surveyed was a mesquite bosque.



Figure 7. Survey area made up of a thicket of tamarisk adjacent to a dried pond in the northwestern part of Bingham Cienega Natural Preserve.



Figure 8. Survey area made up of a mesquite bosque with scattered velvet ash and netleaf hackberry trees, and an understory of graythorn in the northeastern part of Bingham Cienega Natural Preserve.



Figure 9. Survey area near the site of the main cienega (now dry) with a canopy of velvet ash and cottonwood, and an understory of buttonbush and downed woody debris at Bingham Cienega Natural Preserve. The area in the foreground has been thinned to mitigate for fire.

Proposed changes to Pima County's monitoring obligations

The riparian habitat at Bingham Cienega Natural Preserve has been undergoing a long-term drying trend since 2002 that has resulted in substantial decline of woody riparian vegetation and a near elimination of herbaceous riparian vegetation and surface water. This site no longer contains habitat suitable for breeding southwestern willow flycatchers, a fact echoed by the U.S. Geological Survey's consideration of this site as one where this species has been extirpated. In light of this observation, we have proposed to the U.S. Fish and Wildlife Service to no longer perform complete surveys of this site every three years, until and if suitable riparian habitat again becomes available on the site. After review, USFWS staff have agreed to this proposal, with the caveat that Pima County evaluates available riparian vegetation at least every three years (S. Richardson, personal communication, 13 December 2018). If rising shallow groundwater again allows for suitable riparian habitat at this site, Pima County will resume monitoring for flycatchers at this site every three years.

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- Durst, S.L., Sogge, M.K., Stump, Shay D., Williams, Sartor O., Kus, Barbara E., and Sferra, Susan J. 2007. Southwestern Willow Flycatcher Breeding Site and Territory Summary – 2006. USGS Open File Report 2007-1391. [<http://pubs.usgs.gov/of/2007/1391/>].
- Pima County. 2016. Multi-species Conservation Plan for Pima County, Arizona: Final. Submitted to the Arizona Ecological Services office of the U.S. Fish and Wildlife Service, Tucson, Arizona.
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Appendix I. Incidental bird species observed or heard at Cienega Creek Natural Preserve during Southwestern willow flycatcher surveys.

19 May 2017

Common ground dove
Mourning dove
White-winged dove
Arizona Bell's vireo
Abert's towhee
Summer tanager
Western tanager
Empidonax sp.
Western wood-pewee
Cassin's kingbird
Gray hawk
Zone-tailed hawk
Great-horned owl
Yellow-breasted chat (including carrying nesting material)
Northern rough-winged swallow
Purple martin
Common yellowthroat
Lucy's warbler (multiple instances of adults feeding fledged juveniles)
Yellow warbler
Hooded oriole
White-crowned sparrow
Gila woodpecker
Ladder-backed woodpecker
Bewick's wren (carrying food to cavity in standing cottonwood)
Black phoebe
Vermillion flycatcher
Broad-billed hummingbird
Northern beardless tyrannulet
Verdin
Curve-billed thrasher
Yellow-rumped warbler
Wilson's warbler
Black-headed grosbeak
Northern cardinal
Lazuli bunting
Blue grosbeak
Ash-throated flycatcher
Brown-crested flycatcher
Brown-headed cowbird
Northern mockingbird
House finch
Lesser goldfinch
Common raven (nest in cottonwood tree with young)

Appendix I. Continued

15 June 2017

Common ground dove
Mourning dove
White-winged dove
Arizona Bell's vireo (heard calling along most of the course of Cienega Creek; adult seen feeding x2 full-sized fledglings)
Abert's towhee
Summer tanager
Western wood-pewee
Gray hawk
Zone-tailed hawk (x2 likely nests)
Barn owl
Yellow-breasted chat
Northern rough-winged swallow (nesting in at least one section of steep cut bank)
Purple martin
Common yellowthroat
Lucy's warbler (adult feeding fledged juveniles)
Yellow warbler
Gila woodpecker
Ladder-backed woodpecker
Bewick's wren
Black phoebe
Vermillion flycatcher
Broad-billed hummingbird
Black-chinned hummingbird (including female building nest in young ash tree)
Anna's hummingbird
Northern beardless tyrannulet
Verdin
Black-throated sparrow
Northern cardinal
Blue grosbeak
Ash-throated flycatcher
Brown-crested flycatcher
Brown-headed cowbird
Great-blue heron (at one of the large pools full of dace and lowland leopard frog tadpoles)
Common raven (fledglings seen in area of nest)
House finch
Lesser goldfinch
Canyon wren

Appendix II. Incidental bird species observed or heard at Bingham Cienega Natural Preserve during Southwestern willow flycatcher surveys.

16 May 2017

Summer tanager
Western tanager
Yellow-breasted chat
White-throated swift
Cliff swallow
Northern-rough winged swallow
Black-chinned hummingbird (female feeding nestlings at nest in ash about 25 feet up)
Broad-billed hummingbird
Yellow warbler
Lucy's warbler (fledglings being fed in mesquite canopy)
Wilson's warbler
Verdin
Cooper's hawk
Gray hawk
Gila woodpecker
Ladder-backed woodpecker
Mourning dove
Common ground dove
White-winged dove
Common raven
Empidonax sp.
Arizona Bell's vireo
Abert's towhee
Vermilion flycatcher
Northern cardinal
Bewick's wren
Wild turkey
Brown-crested flycatcher
Brown-headed cowbird
Phainopepla
Northern mockingbird
Turkey vulture
Black-tailed gnatcatcher
Eurasian collared dove

Appendix II. Continued

13 June 2017

Purple martin
Abert's towhee
Wild turkey
Brown-headed cowbird
Northern cardinal
Vermillion flycatcher (sitting on nest)
Summer tanager
Yellow-breasted chat
White-throated swift
Black-chinned hummingbird
Broad-billed hummingbird
Yellow warbler (adult seen foraging at blooming saguaro)
Lucy's warbler (fledglings being fed in mesquite canopy)
Verdin
Cooper's hawk
Gray hawk
Gila woodpecker
Ladder-backed woodpecker
Mourning dove
Common ground dove
White-winged dove
Eurasian collared dove
Common raven
Arizona Bell's vireo
Common yellowthroat (one male seen near irrigated orchard and large patch of yerba mansa near house)
Bewick's wren
Red-tailed hawk
Swainson's hawk

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 12

Western Yellow-billed Cuckoo Monitoring Protocol



Pima County Ecological Monitoring Program
Western Yellow-billed Cuckoo Monitoring Protocol
January 2019



Prepared by Pima County Office of Sustainability and Conservation Staff:
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Abstract

This protocol details the structure and results of Pima County's first round of monitoring for western yellow-billed cuckoo, under its Multi-species Conservation Plan (MSCP) and Section 10 permit from the U.S. Fish and Wildlife Service (USFWS). The County has agreed to monitor for the occupancy of this species every three years at Cienega Creek Natural Preserve and Bingham Cienega Natural Preserve, following the currently approved USFWS play callback survey monitoring protocol that dictates four different surveys be completed during three survey periods. Additionally, Pima County allocated additional survey effort to other Pima County preserve lands where cuckoo distribution was less well understood by species experts. These surveys were single pass, exploratory surveys in potentially suitable riparian habitat in Posta Quemada Canyon (Rincon Mountains), Buehman Canyon and Edgar Canyons (Santa Catalina Mountains), and lower Davidson Canyon (south of Cienega Creek). If and where additional exploratory surveys will be completed in future rounds of monitoring for cuckoos will be decided together with USFWS staff. Across the four survey periods we made 52 cuckoo detections at Cienega Creek Natural Preserve, 26 detections at Bingham Cienega Natural Preserve, five detections in lower Buehman Canyon, and one detection in Edgar Canyon. Cienega Creek hosts what is likely a robust breeding population of this species, and Bingham Cienega also likely harbors breeding cuckoos albeit a more modest number of pairs. Observations suggest that small number of cuckoos may breed in both Edgar and lower Buehman Canyons, but the single survey that we made in each site is insufficient to thoroughly evaluate this.

Acknowledgements

We thank Jennie MacFarland, Jonathan Horst, and a host of volunteers, all from the Tucson Audubon Society, for their efforts in completing fieldwork in sometimes inclement conditions. We also thank Iris Rodden for important assistance in completing this fieldwork. Brian Powell also provided key insights, discussion, support, and assistance with fieldwork. Jennifer Becker and Jess Barry provided important logistical support and access to the Bingham Cienega site. We also thank Susan Sferra and Scott Richardson for key discussions on survey placement and other logistics.

Background

Pima County's Multi-species Conservation Plan (MSCP) is tasked with ensuring that the County remains in compliance with its federal Endangered Species Act Section 10 Incidental Take Permit. Implementation of an ecological monitoring program is a key requirement of the MSCP, and Pima County has agreed to conduct species-level monitoring for 15 of the 44 plant and animal species covered under the MSCP. The threatened western yellow-billed cuckoo (YBCU) is one such species that the County has agreed to monitor on the County preserves Cienega Creek Natural Preserve and Bingham Cienega Natural Preserve.

The yellow-billed cuckoo is a secretive and slender, ~30 cm long neotropical migrant bird species that is relatively widespread in forested habitats across the eastern United States, but is rarer and generally restricted to areas with deciduous riparian trees along riparian corridors through parts of western North America. The taxonomic status of the yellow-billed cuckoo, particularly those birds in the western part of their range (referred to in some works as *Coccyzus americanus occidentalis*) is not universally agreed upon and the U.S. Fish and Wildlife Service (USFWS) considers yellow-billed cuckoos that occur in the western parts of North America to be a distinct population segment of the yellow-billed cuckoo, or the western yellow-billed cuckoo. It is clear that the western yellow-billed cuckoo has experienced significant declines, largely associated with losses of riparian cottonwood-willow habitat in the West, and is considered to be extirpated in Washington, Oregon, and British Columbia. Consequently, the western Distinct Population Segment of the yellow-billed cuckoo was federally listed as threatened in 2014.

The western yellow-billed cuckoo primarily breeds in relatively large tracts of native broadleaf deciduous woodlands, which are generally located along streams and rivers. However, recent research and survey efforts have changed the current understanding of what vegetation types should be considered suitable breeding habitat. For example, YBCU will successfully rear broods in Madrean oak woodland associated with mountain canyons, as well as velvet mesquite bosques.

In southern Arizona, YBCU are late-season breeders with peak breeding occurring in July and August. Among bird species, YBCU have one of the most rapid incubation and nestling period with young being capable of fledging (though not flying) approximately 17 days after egg-laying. This species is relatively reclusive, and spends long periods of time at stationary perches in the tree canopy searching for large-bodied invertebrates such as caterpillars, katydids, and cicadas. The YBCU is well known for being capable of eating large numbers of hairy and often noxious caterpillars, prey that are usually ignored by other bird species.

Objectives

Pima County has committed itself to monitoring for the presence of this species using the USFWS-approved call playback survey protocol outlined in Halterman et al. (2015; https://www.fws.gov/southwest/es/Documents/R2ES/YBCU_SurveyProtocol_FINAL_DRAFT_22_Apr2015.pdf). Pima County will monitor for this species in two areas of the County's preserve lands that contain suitable habitat for the species. These areas are Bingham Cienega Natural Preserve and Cienega Creek Natural Preserve where at least one and two transects, respectively, will be established and assessed for occupancy every three years (Pima County 2016).

Methods

In 2017, Pima County used the Halterman et al. (2015) playback survey protocol to assess for the presence of the YBCU on two Pima County preserve properties, Bingham Cienega Natural Preserve and Cienega Creek Natural Preserve (Figure 1). Additionally, County staff completed non-protocol exploratory, one-visit surveys for YBCU in four additional drainages on County preserves upon working with USFWS staff to prioritize areas where survey efforts would be particularly valuable for overall YBCU conservation efforts (Figure 1). For those transects on Bingham Cienega and Cienega Creek, we followed the basic monitoring protocol that prescribes four survey visits completed across the three survey periods (June 15-30, July 1-31, and August 1-15). As indicated by the protocol, two of the survey visits were conducted during survey period two. For the additional, non-protocol surveys we completed one-visit surveys during survey period two.

We used a FoxPro NX4 electronic caller (or similar device) loaded with a recording provided by the USFWS that contained a series of contact ("kowlp") calls beginning at or near sunrise and occurring no later than about 1100 h. We followed a one minute quiet listening period with a series of five contact calls spaced one minute apart. We repeated this every 100 meters as we moved through the habitat to be surveyed. If we detected a cuckoo, we moved at least 300 m further before starting the next survey point. In several cases we moved call points beyond a normally spaced point due to the presence of raptors or raptor nests. We filled out the yellow-billed cuckoo daily datasheet and included the UTM coordinates for each call point. All lead field surveyors had completed the YBCU survey protocol training offered by the USFWS and the Arizona Game and Fish Department. See Halterman et al. (2015) for a complete description of the methodology that we followed.

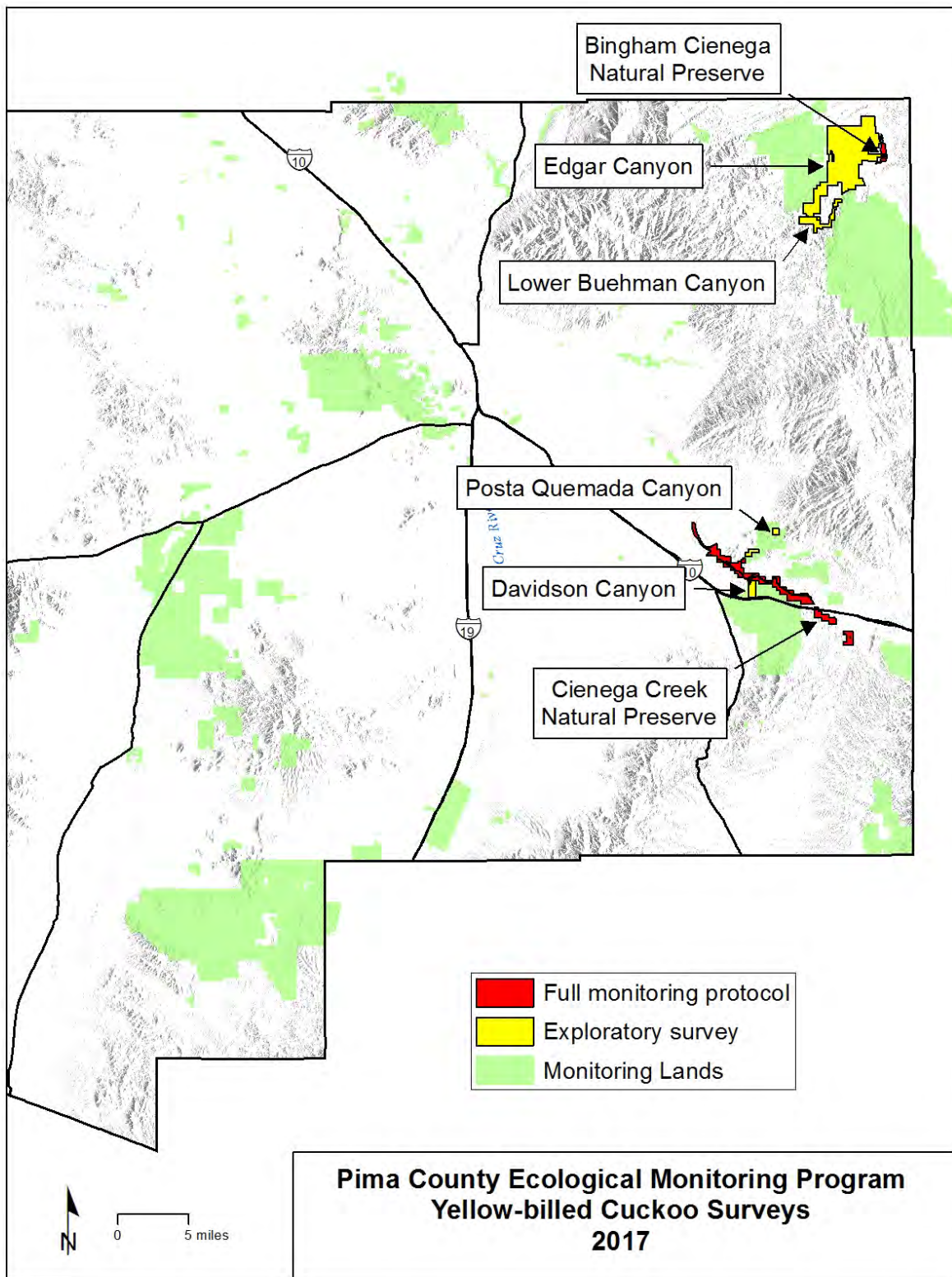


Figure 1. Locations of western yellow-billed cuckoo surveys on Pima County preserve lands. Green shading indicates the breadth of Pima County preserve lands.

Western yellow-billed cuckoo monitoring sites – full protocol surveys

There are patches of appropriate cuckoo habitat (native broad-leafed riparian woodland or mesquite bosque) intermittently spread along much of Pima County's Cienega Creek Natural Preserve. Velvet ash, Goodding's willow, and Fremont cottonwood made up the majority of the broad-leafed riparian woodland. The mesquite bosque was primarily large velvet mesquites and scattered net-leaf hackberry, with understory shrubs such as graythorn. We surveyed approximately 13 km of Cienega Creek, dividing the preserve into two transects with the west transect located between the Del Lago Golf Course diversion dam in the west to the 'Horseshoe Bend' region of Cienega Creek (Figure 2). The east transect took in the area of the Preserve between the 'Horseshoe Bend' region in the west to the abandoned Pantano Townsite in the east, just north of Interstate 10 (Figure 2). Survey transects at Cienega Creek were linear and followed the course of the stream channel (Table 1). Portions of both transects included both wet and dry stretches of Cienega Creek.

Bingham Cienega Natural Preserve is located along a typically dry stretch of the lower San Pedro River. Riparian habitat quality at Bingham Cienega has declined precipitously over the recent past such that the cienega and downstream marshy habitat no longer have surface water, or even moist soil, during early summer. However there are dense mesquite bosques in the north and south end of the Preserve, broad-leaf riparian woodland at the historic cienega (mostly velvet ash with some Fremont cottonwood and Arizona walnut), as well as scattered patches of mesquite with some netleaf hackberry and walnut trees growing along old fencerows and fields. We distributed survey points throughout these habitat patches to ensure complete coverage of the mesquite bosque and broad-leaf deciduous forest habitat which was approximately 2.1 km of survey transect (Table 1; Figure 3).

Western yellow-billed cuckoo monitoring sites – exploratory surveys

Pima County offset a reduction in monitoring for southwestern willow flycatchers due to a lack of suitable habitat, with additional exploratory surveys for western yellow-billed cuckoos. These were single-pass cuckoo surveys implemented in areas of County preserves that in consultation with USFWS staff, were determined to be areas where the status of cuckoo presence was lacking or insufficient. Consequently, we conducted single survey pass cuckoo surveys in suitable habitat in Edgar and Buehman Canyons (Santa Catalina Mountains) and in Posta Quemada Canyon (Rincon Mountains). We also completed a single pass survey in the County-owned portion of Davidson Canyon, south of Cienega Creek Natural Preserve. We completed all of the exploratory periods during survey period 2, when detectability would be likely to be highest.

Posta Quemada Canyon is located in Pima County's Colossal Cave Mountain Park, in the Agua Verde Creek drainage at the south end of the Rincon Mountains. Surveys were in an ephemeral stretch of the canyon with a small section of native broad-leaf riparian woodland (mostly cottonwood with some velvet ash and Goodding's willow) and mesquite bosque (Table 1). County staff also completed an exploratory survey of the County-owned part of Davidson Canyon south of Cienega Creek. Habitat here was mostly velvet mesquite, interspersed with

occasional Goodding’s willow and velvet ash, and ephemeral stretches with small amounts of water (Table 1).

Surveys on County-owned lands in Edgar (Figure 1; Table 1) and lower Buehman Canyons (Figure 6; Table 1) (both draining into the lower San Pedro River) were located on the east side of the Santa Catalina Mountains. We completed one transect in Buehman Canyon including on a property that Pima County recently acquired (Tesoro Nueve Ranch). Areas surveyed were intermittent streams, containing some permanent water, under a canopy of native broad-leaved riparian woodland (sycamore, velvet ash, walnut, Goodding’s willow and cottonwood) intermixed with mesquite bosque.

Table 1. Location of Pima County western yellow-billed cuckoo survey transects (2017). UTM coordinates are given in the datum NAD83.

Site	Survey Start		Survey End	
	UTM Easting	UTM Northing	UTM Easting	UTM Northing
Cienega Creek Natural Preserve*				
West transect	530586	3544429	535780	3541921
East transect	535886	3541974	540143	3539629
Bingham Cienega Natural Preserve**				
Bingham	548477	3592276	548159	3590113
Exploratory Surveys*				
Posta Quemada Canyon	534631	3546685	534315	3546151
Davidson Canyon	533364	3538656	533704	3542352
Edgar - upstream	541205	3591668	541704	3591346
Edgar - downstream	542936	3590538	543550	3590434
Buehman	542290	3583332	543596	3585876
Buehman – Tesoro Nueve	543281	3586790	543573	3586435

*Locations provided are the start and end points of linear transects following the stream channel.

**Locations provided are the approximate north and south bounds of the area surveyed within Bingham Cienega.

Results

Cienega Creek Natural Preserve

Cuckoos are densely distributed along the surveyed portions of the Cienega Creek property. We detected cuckoos in both mesquite bosque and native riparian woodland habitats. We made 52 detections of an estimated 50 individual cuckoos across the survey periods. The greatest number of cuckoos detected was 18 during survey period 3, and the fewest detected was eight during survey period two (survey 2a; 14 and 17 July 2017; Table 2). Thirty of these detections were aural only, three detections were visual only (silent birds), and 17 detections were birds that were both heard and seen (in two cases detection method was not recorded). In cases where cuckoos were detected through their calls, two were alarm calls, 41 were contact calls, one individual made both a contact and an uncategorized vocalization, and one was a coo call. Ten cuckoo detections were made before any playback was broadcasted at a station. For

cuckoos detected after broadcasting calls, it took an average of about two rounds of calls before detecting a bird.

Estimated Territories

We used the guidelines presented in Halterman et al. (2015) to estimate and qualify the number of potential cuckoo territories along survey transects. In the western part of the Cienega Creek Preserve, we estimate that there were two possible breeding territories and one probable breeding territory. In the eastern part of the Preserve, we estimate that there were five probable breeding territories, four possible breeding territories, and one confirmed breeding territory.

Habitat Characteristics

The surveyed stretches were primarily native vegetation (> 75%) with the four most prevalent overstory species being Fremont’s cottonwood, Goodding’s willow, velvet ash, and velvet mesquite. There are four reaches of perennial water throughout the survey transect. We estimated that overall there was about 75% canopy cover and that the canopy was on average 12 m tall. There was also about 30% canopy cover of understory vegetation (~ 2.5 m tall on average), and the five most common understory species were velvet mesquite, velvet ash, Goodding’s willow, netleaf hackberry, and seep willow. Tamarisk, though present, was widely scattered and relatively rare.

Table 2. Summary survey results for Pima County western yellow-billed cuckoo monitoring (2017).

Site	Transect distance (km)	Survey Period 1 June 15 - 30	Survey Period 2 July 1 – 31 (2 surveys)	Survey Period 3 August 1 - 15
		YBCU detections	YBCU detections	YBCU detections
Full protocol sites				
Cienega Creek Natural Preserve*	13.0	18	8 (survey 2a) 16 (survey 2b)	10
Bingham Cienega Natural Preserve	2.1	5	9 (survey 2a) 6 (survey 2b)	6
Exploratory survey sites				
Lower Buehman Canyon	3.3	1 (incidental)	2	N/A
Tesoro Nueva (Lower Buehman Canyon)	0.6	N/A	2	N/A
Edgar Canyon**	1.2	N/A	0	1 (incidental – 09/19/2017)
Posta Quemada Canyon	0.6	N/A	0	N/A
Davidson Canyon	4.4	N/A	0	N/A

**Two discontinuous stretches surveyed combined.

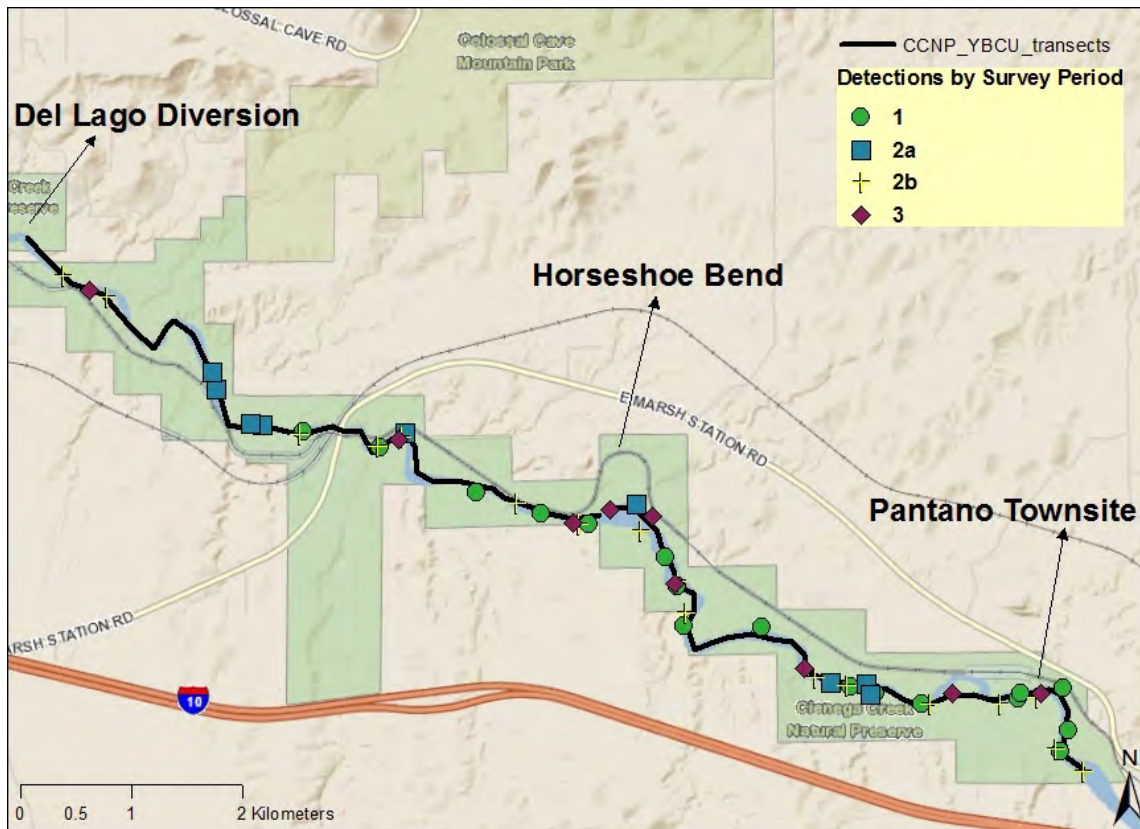


Figure 2. Western yellow-billed cuckoo detections by survey period on Cienega Creek Natural Preserve.



Figure 3. Survey stretch with a well-developed canopy of Fremont cottonwood, velvet ash, and Goodding's willow at Cienega Creek Natural Preserve.

Bingham Cienega Natural Preserve

We detected cuckoos throughout the Bingham Cienega Natural Preserve property. We made 26 detections of an estimated 24 individual cuckoos across the survey periods. The most cuckoos detected on a particular survey (survey 2a; 14 July 2017) was nine, while the fewest detected birds on a given survey was four in periods one and two (survey 2b; 07/26/2017; Table 2). Cuckoos were detected throughout the preserve with detections occurring during all of the surveys in mesquite bosque habitat in the northern part of the property as well as the mix of riparian broad-leaf woodland near the dry cienega in the central part of the preserve. We detected cuckoos during some (but not all) of the survey periods in the mesquite bosque habitat in the southern part of the preserve. Twelve of these detections were aural only, three detections were visual only (silent birds), and 11 detections were heard and seen. In cases where cuckoos were detected through their calls, 15 were contact calls, three were coo calls, five were coo and contact calls, and one was an alarm call. We made nine cuckoo detections before any playback was broadcasted at a station. For cuckoos detected after broadcasting calls, it took an average of about three rounds of calls before detecting a bird.

Estimated Territories

Using the instructions regarding interpretation of breeding status given in Halterman et al. (2015) we estimate that there were three probable breeding territories and two possible breeding territories at this site.

Habitat Characteristics

The surveyed areas were primarily native vegetation (> 75%) with the five most prevalent overstory species being velvet mesquite, netleaf hackberry, velvet ash, Goodding's willow, and Fremont's cottonwood. The only available permanent surface water on the site is a small well-fed pond that is adjacent to the Bingham Cienega ranch house. The broad-leaf riparian trees have experienced substantial levels of canopy dieback and mortality due to ongoing drought and decline of the shallow groundwater level. We estimated that overall there was about 65% canopy cover and that the canopy was on average 8 m tall. There was also about 10% canopy cover of understory vegetation (~ 1.5 m tall on average), and the three most common understory species were buttonbush, graythorn, and velvet mesquite.

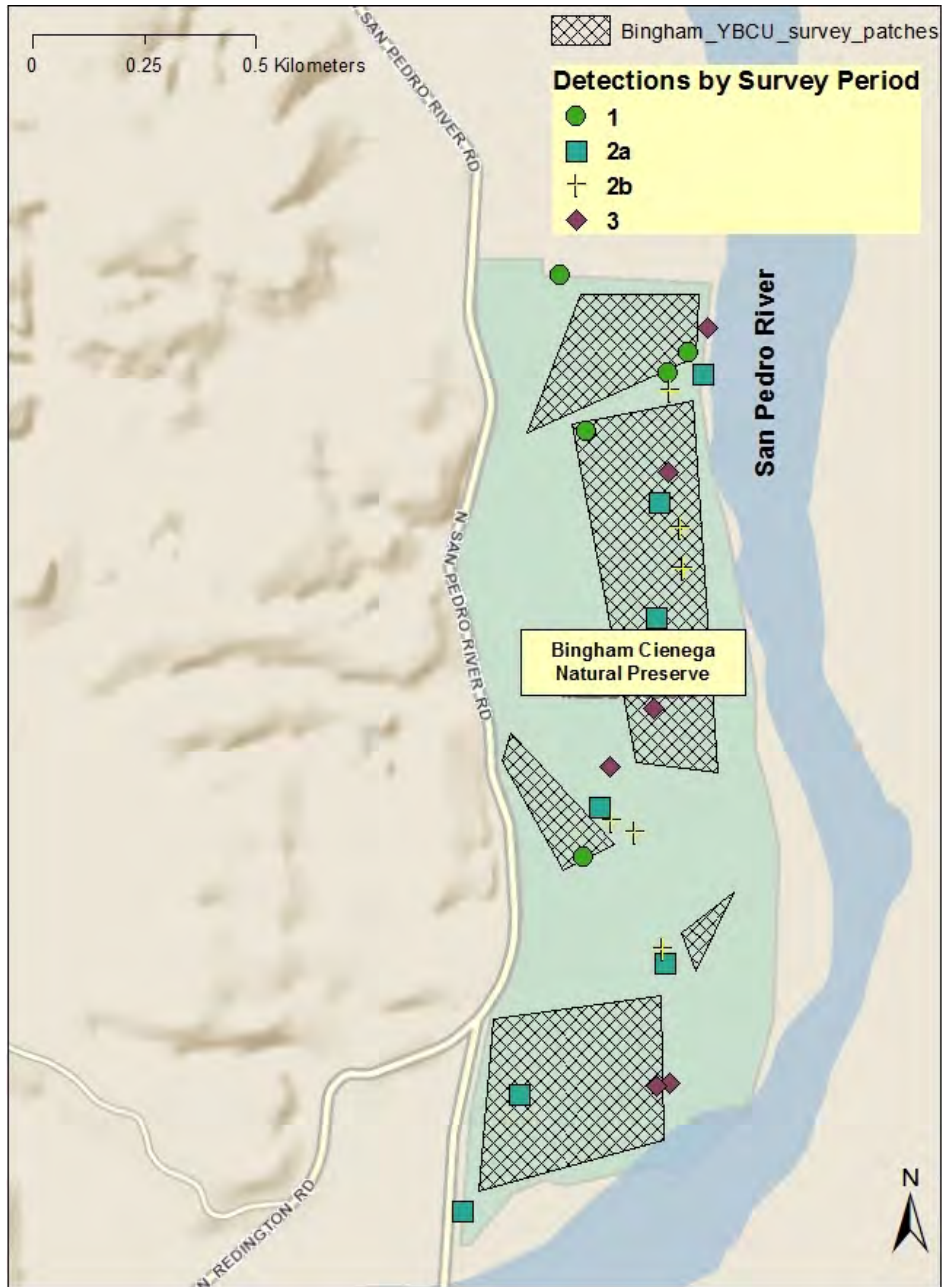


Figure 4. Western yellow-billed cuckoo detections by survey period on Cienega Creek Natural Preserve. Survey patches approximate the area of potential mesquite bosque or broad-leaf deciduous tree habitat that are interspersed with more open and shrubby habitat.



Figure 5. Survey area made up of a mesquite bosque with scattered velvet ash and netleaf hackberry trees, and an understory of graythorn in the northern part of Bingham Cienega Natural Preserve.

Lower Buehman Canyon

We made four cuckoo detections of four different individuals during a single pass exploratory survey (across two separate surveyed lengths) of Lower Buehman Canyon (Figure 6, Table 2). We also made a visual incidental observation of a silent cuckoo in lower Buehman Canyon during other work in survey period 1 (26 June 2017). Two of the four protocol detections were made before any broadcasted calls were played at a station. In the other two cases, birds responded after two and four series of broadcasted calls. Three individuals were only detected aurally, and one bird flew into the station after call broadcast, but never vocalized. The three birds that vocalized all made contact calls.

Estimated Territories

We only completed a single survey, but given the incidentally observed bird made in June during survey period 1 (about 490 m away from the closest observation in July), we can say that there was at least one possible breeding territory.

Habitat Characteristics

The surveyed areas were primarily native vegetation (> 75%) with the five most prevalent overstory species in the lower Buehman transect being in order of abundance Arizona

sycamore, Fremont cottonwood, Goodding’s willow, Arizona walnut, and velvet ash. This part of Buehman Canyon contains perennial, but intermittent flow, and all call stations were at a minimum within several hundred meters of surface water. We estimated that overall there was about 80% canopy cover and that the canopy was on average 15 m tall. There was also about 40% canopy cover of understory vegetation (~ 3 m tall on average), and the five most common understory species were netleaf hackberry, velvet ash, Arizona walnut, canyon grape, and velvet mesquite. The Tesoro Nueve transect was also centered along an area of permanent surface water in Buehman Canyon (Figure 7) and we estimated that it had about 85% canopy cover (on average about 18 m high) of overstory tree species including Fremont cottonwood, velvet ash, Goodding’s willow, velvet mesquite, and Arizona walnut. The most common understory species (about 20% understory canopy coverage and 1.5 m tall) included graythorn, catclaw acacia, Cochise sedge, velvet ash, and netleaf hackberry.

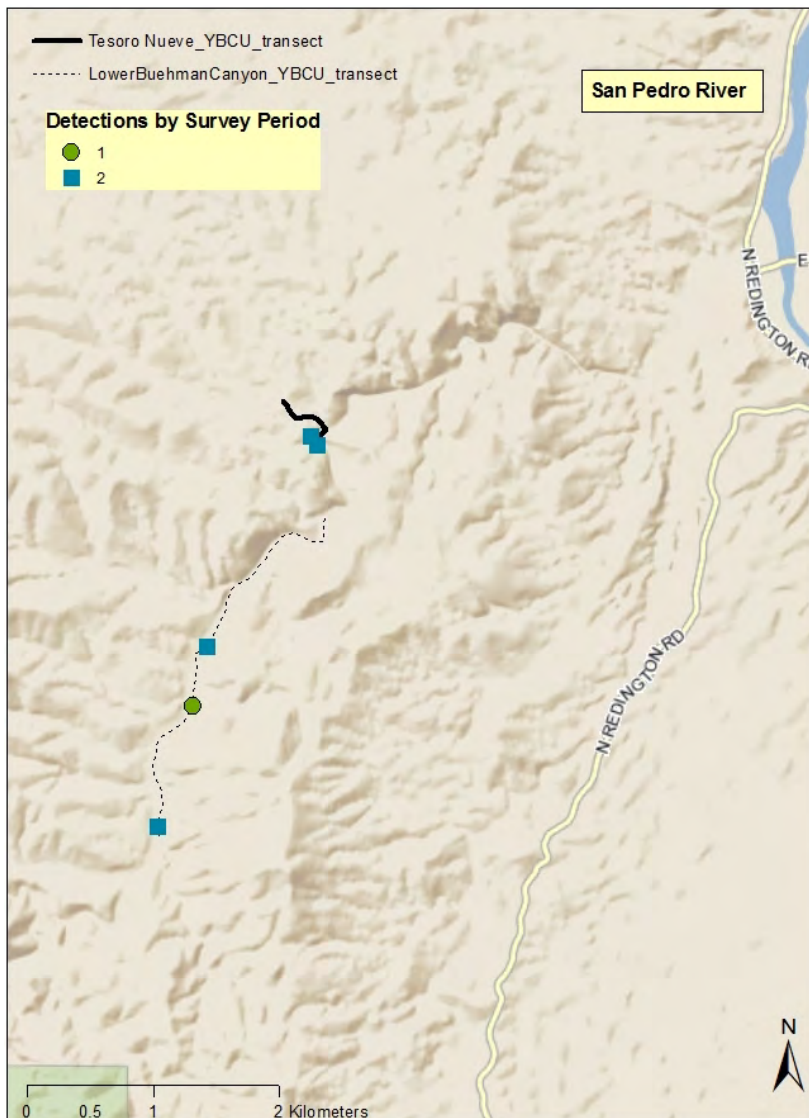


Figure 6. Western yellow-billed cuckoo detections during a single, exploratory survey during survey period 2. The green circle indicates a cuckoo that was incidentally observed during other work in June.



Figure 7. Spring at part of the Tesoro Nueve survey transect for western yellow-billed cuckoo in the Buehman Canyon Preserve.

Edgar Canyon

We did not detect any cuckoos during a single pass exploratory survey (across two separate surveyed lengths) of Edgar Canyon (Figure 8, Table 2). However, we made a single incidental observation here of a cuckoo giving an alarm call on 19 September in the course of other work. Addendum: during other work in 2018, we detected a calling cuckoo about 150 m downstream of the 2017 detection, on 13 June 2018.

Estimated Territories

We only surveyed once at this location, but the fact that we observed and heard a cuckoo giving repeated alarm calls in September, indicates that there may have been a breeding territory at this site.

Habitat Characteristics

The surveyed areas were primarily native vegetation (> 75%) with the five most prevalent overstory species being in order of abundance Arizona sycamore, Fremont cottonwood, Goodding's willow, velvet ash, and velvet mesquite. This part of Edgar Canyon contains perennial, but intermittent flow, and all call stations were at a minimum within several hundred meters of surface water (Figure 9). We estimated that overall there was about 65% canopy

cover and that the canopy was on average 12 m tall. There was also about 20% canopy cover of understory vegetation (~ 1.5 m tall), and the five most common understory species were netleaf hackberry, velvet mesquite, velvet ash, graythorn, and desertbroom.



Figure 8. Western yellow-billed cuckoo survey transect, Edgar Canyon. We detected no cuckoos during a single, exploratory survey during July, but did incidentally observe a cuckoo at this site in September.



Figure 9. Native broadleaf deciduous riparian forest characterizing western yellow-billed cuckoo survey areas at Edgar Canyon.

Posta Quemada Canyon

We did not detect any cuckoos during a single pass exploratory survey of Posta Quemada Canyon (Figure 10, Table 2).

Habitat Characteristics

The surveyed areas were primarily native vegetation (> 75%) with the four most prevalent overstory species being in order of abundance, Fremont cottonwood, Goodding's willow, velvet mesquite, and netleaf hackberry. During our survey, there was no available surface water. We estimated that overall there was about 75% canopy cover and that the canopy was on average 8 m tall. There was also about 40% canopy cover of understory vegetation (~ 3 m tall), and the five most common understory species were velvet mesquite, netleaf hackberry, Goodding's willow, velvet ash, and buttonbush.

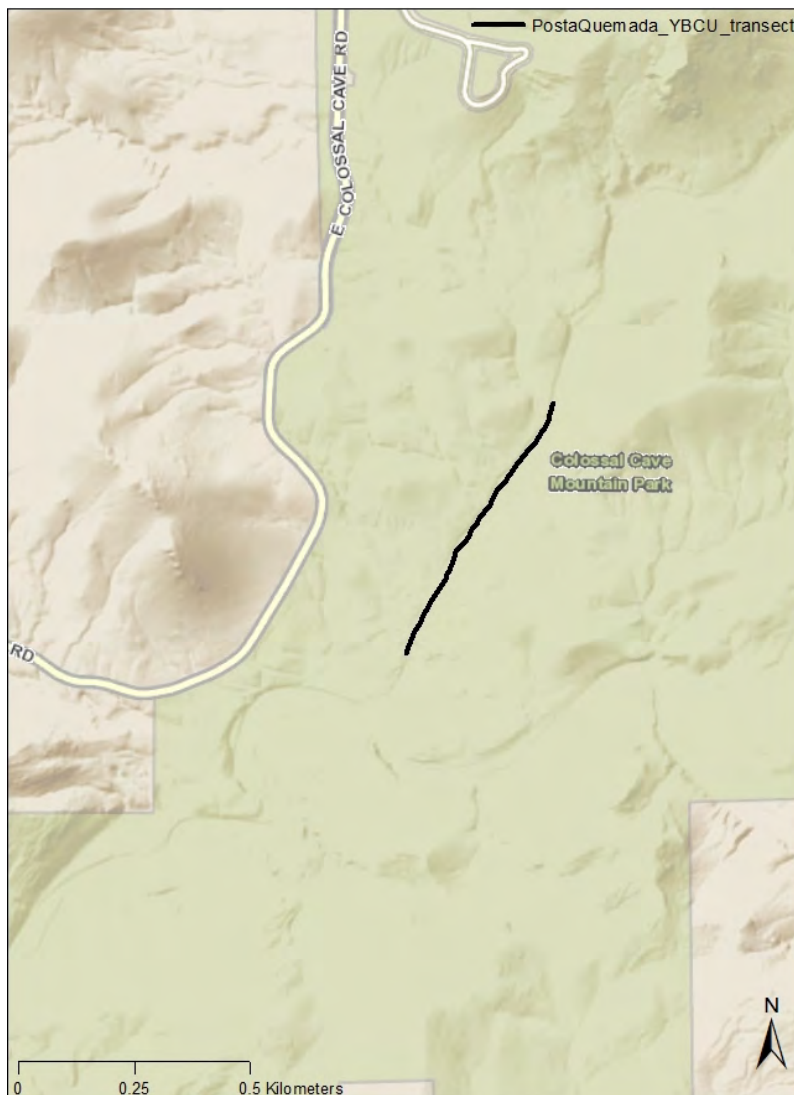


Figure 10. Western yellow-billed cuckoo survey transect in Posta Quemada Canyon, Colossal Cave Mountain Park, Rincon Mountains.

Davidson Canyon

We did not detect any cuckoos during a single pass exploratory survey of Davidson Canyon (Figure 11, Table 2).

Habitat Characteristics

The surveyed areas were primarily native vegetation (> 75%) with relatively sparse overstory canopy cover. The four most prevalent overstory being in order of abundance were velvet mesquite, velvet ash, Goodding's willow, and netleaf hackberry. By far the the majority of the canopy cover was velvet mesquite. Throughout the survey length, there were intermittent length of surface water flow, although much of this flow is not considered to be permanent. We estimated that overall there was about 25% canopy cover and that it was on average 8 m tall. There was also about 10% canopy cover of understory vegetation (~ 1.5 m tall), and the four most common understory species were velvet mesquite, netleaf hackberry, desertbroom, and seepwillow.

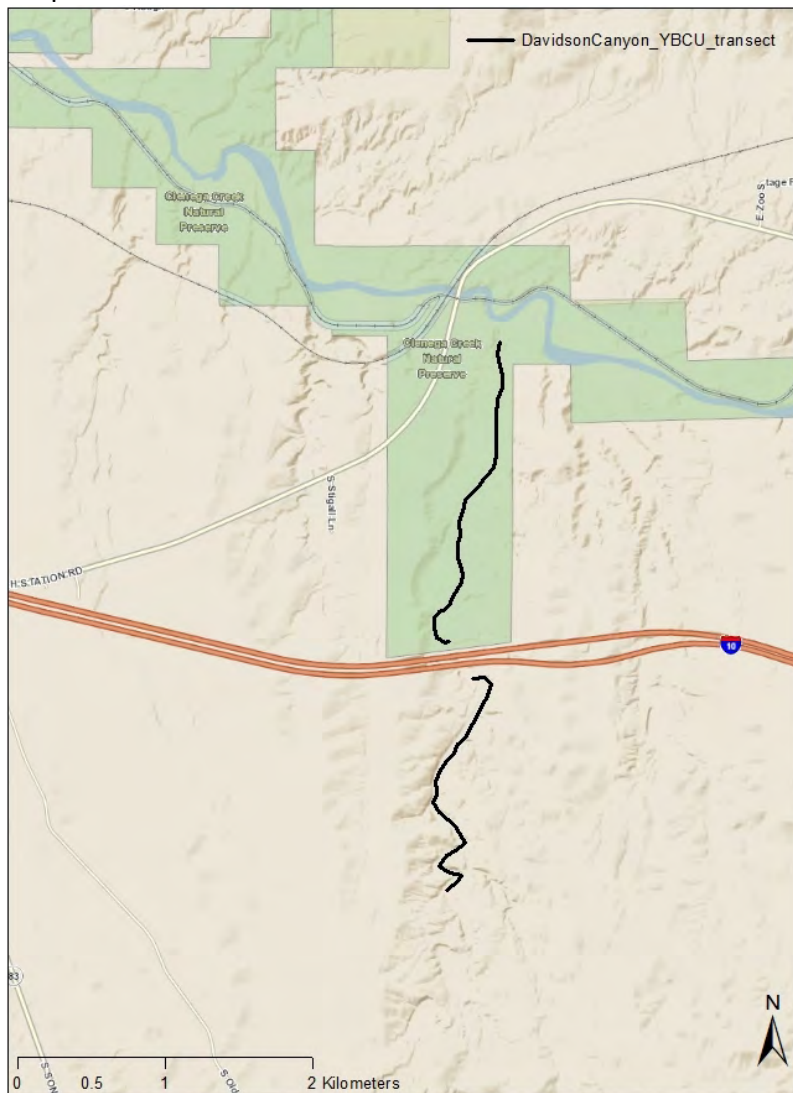


Figure 11. Western yellow-billed cuckoo survey transect in Davidson Canyon, south of Cienega Creek Natural Preserve.



Figure 12. Scattered and sparse riparian forest along western yellow-billed cuckoo survey area in lower Davidson Canyon. Outside of wet periods, surface water flow is drastically reduced or absent.

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Appendix 13

**Draft Pima Pineapple Cactus Monitoring Protocol –
Health Condition Assessment Rubric**

Pima County Pima Pineapple Cactus Monitoring Protocol – Draft Condition Assessment Rubric

The following is an excerpt from the draft Pima County Pima Pineapple Cactus (PPC) Monitoring Protocol, in which we discuss field measurements including a proposed condition assessment rubric. We also include the associated draft field data form to record observations during proposed PPC distance sampling efforts.

Plant Location, Morphological Measurements, and Condition Metrics

The following measurements should be taken when an observer encounters an individual PPC while implementing the distance sampling protocol or for an incidental observation during general monitoring efforts. Metrics are quantitative in nature as to facilitate the repeatability of measurements when individuals are possibly revisited as part of the County's regular monitoring efforts or on the County's mitigation bank properties.

GPS Location

The precise GPS location should be recorded for each individual PPC observed. This location should be taken within 1m of the plant as to minimize error with potential future relocation of the individual. If possible, use point averaging with five or greater locations to increase GPS accuracy. If multiple plants are located within the range of error of the GPS device (~3-5m), a single point can be used for all individuals, however make sure to note the orientation of those plants in the notes for that GPS location.

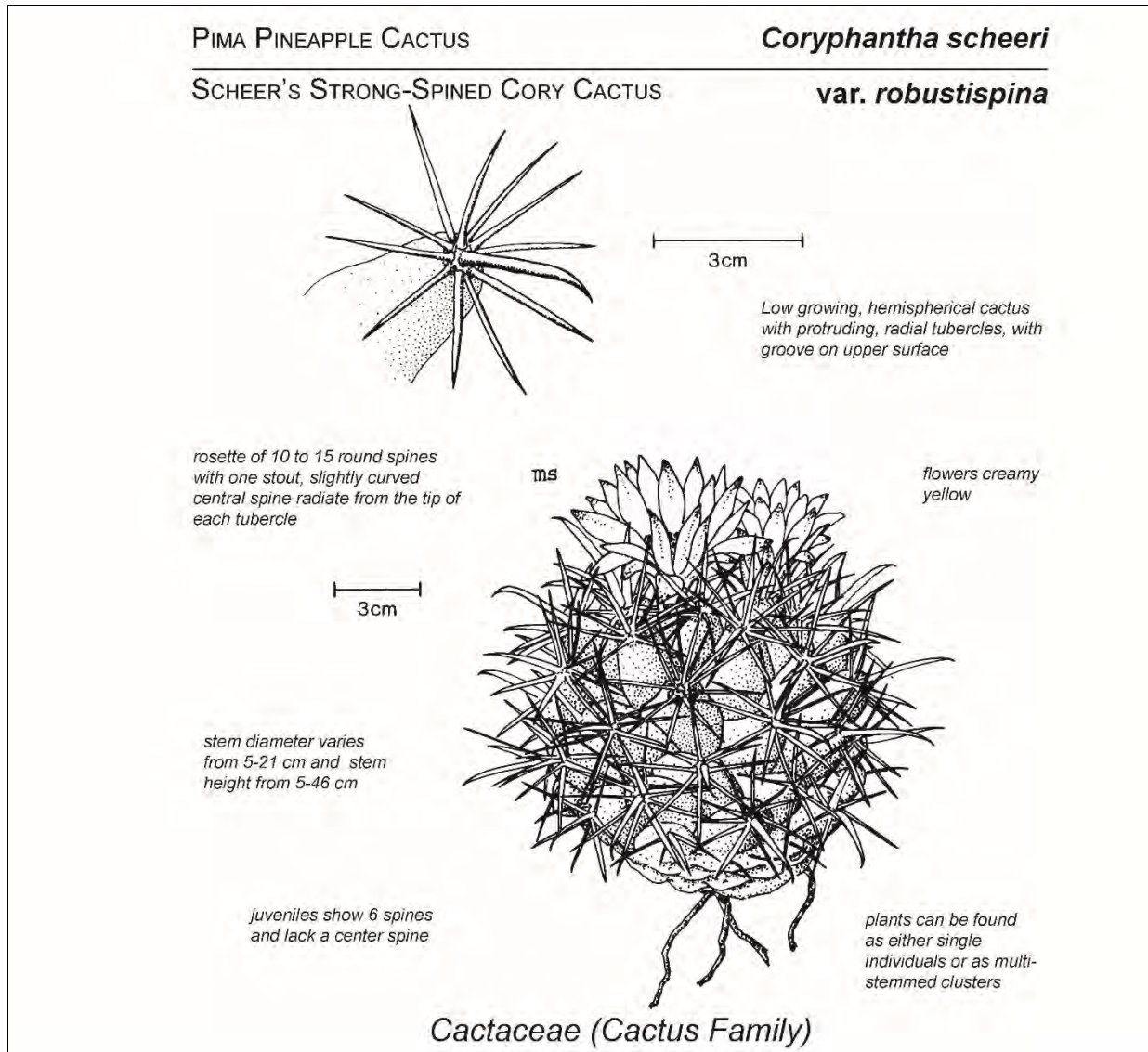
Morphological Measurements

It is important to record morphological measurements for PPC so as to compare growth across multiple observations. This protocol seeks to quantify plant size and the evidence of current or prior reproduction. The three morphological measurements to record are 1) the total number of stems differentiated by mature, immature, and dead stems, 2) the height and width of the tallest single stem and the widest point of the plant if multi-stemmed, and 3) the number of active and aborted buds, flowers, and fruits (Appendix A).

Mature and immature stems are differentiated using grooves on the dorsal (upper) side of the tubercles (Baker 2004). Mature stems have tubercles with grooves running the full length from the base to tip of the tubercle, while immature stems may have a partial groove or no groove on tubercles. Dead stems may stay standing and attached to the main plant for a long time after dying; individual plants may have multiple mature, immature, and dead stems.

Plant size is quantified by measuring height and maximum width of the single largest stem and maximum width of the overall plant if there is more than one stem. Height is measured from the base of the plant on the downhill side to the top of the tubercles on the largest stem; spines

are not included in height measurements. It is useful to have a thin, rigid tool (i.e. bicycle spoke, pin flag) threaded in between the spines on the top of the stem to measure height; this method reduces visual estimation bias. Stem width is measured from the outside of the tubercles on one side to the other side along the widest axis of the stem. The rigid tool is not required for this method as observer location above the plant allows for accurate measurements. Plant width is also measured from the outside of the stem on one side of the plant to the outside of the stem on the other side along the widest axis of the plant; this measurement is also tubercle to tubercle as with stem width.



Arizona Rare Plant Field Guide entry for Pima Pineapple Cactus (*Coryphantha sheeri* var. *robustispina*).

Evidence of reproduction in Sonoran desert cacti may vary based up plant health, time of survey within season, and interannual variability in precipitation (Roller 1996, Steenberg and Lowe 1977, McDonald and McPherson 2005, Bustamante and Búrquez 2008). Healthy individuals should have the potential to be reproductively active in years when environmental

conditions are suitable, while stressed individuals may not be (Roller 1996). We differentiate between a bud, flower, and fruit based on Baker's (2013) prior monitoring work. Buds are flowers that have not yet matured or opened and are typically present on the plant in the 4-6 weeks before the first monsoonal rains (mid-May – end of June). Flowers open very shortly after the first monsoonal rains and may be present for several weeks in July. Fruits usually form by August and will grow underneath the terminal spines at the top of the plant. PPC fruits are consumed by many wildlife species and will often be removed shortly after ripening. Buds, flowers, and fruits can all be aborted during the growing season and these should also be documented along with actively growing reproductive features. Please see Appendix B for additional photos of PPC reproductive parts.

General Condition Score

Pima County seeks to develop a quantitative, robust, and repeatable general condition assessment for PPC. Prior PPC monitoring efforts have measured condition qualitatively, using terms such as "excellent," "good," "fair," "poor," or "dead" (Baker 2010). These qualitative scores may vary drastically based on the observer's experience with the species. County staff have identified four criteria deemed important for assessing general cactus health that can be observed in a non-invasive manner: 1) plant herbivory, 2) disease, desiccation, and/or discoloration, 3) erosion/digging, and 4) evidence of recent production. It is assumed that all stems are experiencing similar resource conditions, therefore these metrics are assessed across all of the living tissue of a plant, rather than on just the single largest stem. Death of a single stem does not necessarily lead to overall plant mortality, however this protocol only assesses the condition of the currently living stems as identified in the Morphological Measurements section above. We clearly define the scoring criteria for the condition metrics (Appendix A) and provide additional *in situ* photo documentation of PPC for clarification purposes (Appendix B).

PPC are herbivorized by several species of insects and small mammals, and herbivory is one of the primary factors responsible for PPC seedling mortality (Roller 1996). Jack rabbits and ground squirrels are known to herbivorize stems if they can bypass or remove spines. Small insects can bore into tubercles, termites can build mud casings on lignified portions of stems, and ants can harvest freshly opened flower petals (Baker 2010). The score for plant herbivory is based on a visual estimation of the amount of herbivory present across the entire surface of the living part of the plant.

Cacti can become diseased, desiccated, or discolored when stressed (Barcikowski and Nobel 1984). On PPC, older tubercles often become lignified and blackened as compared to newer tubercles, and plants can discolor to a slight reddish hue when drought stressed. This metric assesses any obvious discoloration or desiccation beyond the above lignification or drought stress. Tissue can appear wrinkled or even necrotic when plants are severely stressed. This metric does not seek to determine the mechanism behind the stress, only to describe the severity of it. As with herbivory, this metric is a visual estimation of the severity of the symptoms and the extent across the entire living surface of the plant.

Water erosion or digging by animals may destabilize cacti and lead to pedestaling, exposed roots, and possibly uprooting (Pima Co. staff observation). This in turn may potentially lead to decreased fitness or even mortality for PPC. This metric is again visually estimated, with scores ranging from no evidence of soil loss to severe soil loss with pedestaling and exposed roots.

Lastly, evidence of current or prior seasons' reproduction is useful in determining plants response to stress. Aborted buds and flowers will often remain trapped within the terminal spines of a mature stem. Fruits also mature beneath these spines but are often harvested quickly once ripe. This metric does not differentiate between current or prior years' reproduction, but rather seeks to determine if individuals have been reproductively active in the recent past. Note that lack of evidence of active or aborted flowers or fruits does not necessarily signify lack of recent reproductive activity.

Notes, Comments, and Photographs:

Recording descriptive notes and taking documentation photos about interesting or unique individuals is important when appropriate. Documenting notes on physiological condition outside of the general condition assessment (i.e. generating new tubercles/spines, unique coloration or disease, presence of insect pest or pollinator) is useful when appropriate. If a PPC has a unique characteristic (i.e. crested individual, strange growth, massive herbivory) or the surrounding environment is different (i.e. severe erosion, extreme number of rabbit pellets) then taking either a high resolution close-up or landscape photo is appropriate.

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PPC Distance Sampling Data Form

Date _____ Observer _____

LOCATION

GPS Waypoint Number _____ Photo Number _____
Distance from Line _____ Angle from Line _____

IDENTIFICATION

Plant ID # _____

MORPHOLOGICAL MEASUREMENTS

Stem Count (#)

Mature Stems (heads) Live _____ Dead _____
Immature Stems (pups) Live _____ Dead _____

Stem and Plant Size (mm)

Tallest stem height _____
Tallest stem width _____
Total plant width at widest point (if >1 stem) _____

Reproductive Measurements

Buds Active _____ Aborted _____
Flowers Active _____ Aborted _____
Fruits Active _____ Aborted _____

GENERAL PLANT CONDITION RATING

Herbivory _____

- 3 – No or extremely minimal herbivory present
- 2 – < 10% of total plant surface herbivorized
- 1 – 10 – 25% of total plant surface herbivorized
- 0 – > 25% of total plant surface herbivorized

Disease, desiccation, or discoloration (DDD) _____

- 3 – Healthy plant, no evidence of DDD
- 2 – Slight evidence of DDD, limited to small part of the plant
- 1 – Moderate evidence of DDD, evident across much of the plant
- 0 – Severe evidence of DDD, across much/all of the plant, mortality likely

Erosion _____

- 2 – No erosion/soil loss/digging present
- 1 – Minimal erosion, no exposed roots
- 0 – Severe erosion, pedestaling, exposed roots

Evidence of recent production _____

- 1 – Any evidence of recent production – buds/flowers/fruits present
- 0 – No evidence of recent reproduction

Cumulative Score (, , ,)

Notes _____

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Appendix 14

**Location and Status of Unsupplemented, Foresummer Surface
Water on Pima County Conservation Lands, 2011-2017
Final Report**

Location and Status of Unsupplemented, Foresummer Surface Water on Pima County Conservation Lands, 2011-2017

**Final Report
April 18, 2018**



Stream reach in Buehman Canyon

**Brian Powell
Pima County Office of Sustainability and Conservation
Brian.Powell@pima.gov**

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Executive Summary

Surface water is a rare and limiting resource in desert environments. For animals in the Sonoran desert, surface water during the dry foresummer season is particularly important because of the increased demand for water at that time and because the extent of surface water is at its minimum. This report summarizes seven years of surveys to map the location of all naturally occurring (i.e., unsupplemented) surface water (stock tanks and dams, springs, and streams) throughout Pima County's extensive system of conservation lands. Unsupplemented surface water was extremely rare and often spatially and temporally variable. Specifically, staff made 145 visits to 58 sites: 42 had surface water in at least one year, but only 20 sites (5 stock tanks, 6 springs, and 9 streams) with visits in two or more years had surface water present on each visit. At sites that consistently had water in the foresummer, their spatial extent was very limited and subject to high variability between years.

Though surface water plays a critical role in maintaining local species diversity, threats to unsupplemented features abound, most importantly the current and persistent drought and climate change. Management actions such as improving water-holding capacity of select features, sound management of contributing uplands, and assertion of County-held water rights can help ensure the persistence of unsupplemented surface waters. Pima County will continue to monitor key surface water sites during the arid foresummer as part of the Pima County Ecological Monitoring Program, a key element of the Multi-species Conservation Plan (MSCP). Data from the annual surface water monitoring effort will also inform various County land management plans that are both a requirement of the MSCP and our commitment to sound stewardship of the public's resources on these conservation lands.

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Introduction

Perennial or near-perennial surface water in arid environments is essential for a host of resources including native species such as fish, frogs, and aquatic invertebrates, but also for many terrestrial animals (O'Brien et al. 2006). The importance of water was recognized in the development of the Sonoran Desert Conservation Plan (SDCP), which had a significant focus on riparian and aquatic resources (e.g., Fonseca et al. 2000; Pima County 2000b; Rosen 2000; Pima County 2002). Scarce before the SDCP planning process began in the late 1990's, surface water volume and extent has contracted even further in Pima County because of the persistent drought currently gripping the region (e.g., Powell 2013).

Protection of water resources was a driver of Pima County's most recent and significant land acquisition program, which began in 2005 as a result of voter-approved bonds. Since then the County has purchased over 50,000 acres of fee lands and leased over 135,000 acres of state and federal lands. Other funding (e.g., Floodprone Land Acquisition Program) and donations have brought the total acres under Pima County and Regional Flood Control District ownership and management to over 225,000; collectively, these lands are referred to as Pima County conservation lands. Despite the County's due diligence efforts at the time of each property acquisition, however, very little was known about the location, extent, and condition of key natural resources on these lands. Particularly lacking has been information on surface water.

While surface water can be—and in some cases is—inventoried and monitored at various times throughout the year in our region, June is considered the peak of the dry foreshummer in the Sonoran Desert and is an ideal time to survey for the presence of surface water (Turner and Richter 2011); sites that consistently maintain surface water through to the start of the monsoons can often be considered truly perennial. Information about surface water can be used for a host of management applications including creation or enhancement of features to hold more water, water rights assertions, and application of water quality standards (e.g., Outstanding Arizona Waters).

Monitoring the inter-annual variation in foreshummer surface water can help to understand and predict the impacts of prolonged drought and climate change on wide range of ecosystem structures and functions, from groundwater recharge to plant and macroinvertebrate community composition (e.g., Bogan and Lytle 2011; Katz et al. 2012). The emerging fields of disturbance and “temporary-river” ecology (Larned et al. 2010) are providing new insights into—and showing value of—dynamic perennial, intermittent, and ephemeral aquatic systems of the arid southwest (e.g., Bogan et al. 2015) and potential management responses to changes (Lacher et al. 2014). Managing systems for environmental flows that sustain basic ecological and hydrological structures and functions is an area of particular importance given the climatic and land-use changes of the Anthropocene (Tharme 2003; Arthington et al. 2006; Acreman et al. 2014).

Pima County's Surface-water Monitoring Efforts

Pima County and the Pima Association of Governments have been monitoring surface water since the 1980s at the Cienega Creek Natural Preserve (Pima Association of Governments 2009; Powell 2013), and inventory and monitoring efforts have expanded in recent years with the County's land acquisitions and leases. The first effort to document the location of foresummer surface waters on County conservation lands outside of Cienega Creek and Davidson Canyon was undertaken in 2011 (Powell 2011). However, with the approval of the Multi-species Conservation Plan in 2016 (MSCP; Pima County 2016), Pima County's effort to document these sites has increased significantly. That year began the Pima County Ecological Monitoring Program (EMP), which has a mandate to support the MSCP by monitoring a host of resources including select aquatic and riparian species and their habitats (Pima County 2016).

This report summarizes the most current findings from the County's ongoing inventory of surface water on County conservation lands; it focuses on stock tanks and dams, springs, and stream segments that are "unsupplemented" because they receive no direct water inputs from human-built features such as wells, pipes, and pumps. Temporally, the foci of this report is on the foresummer, thus excluding other periods of the year when surface water extent and volume might be greatest, such after storm events and during the winter.

Methods

Field surveys took place at the following feature types (Figure 1):

- Stock Tanks and Dams. These are human-made features that capture surface water runoff for use by cattle and/or wildlife. In some cases, developed waters such as tanks were built on top of—or otherwise capture—spring water, but lacking additional information, they are classified as stock tanks and dams. These features do not include "wildlife drinkers" and/or metal stock tanks. This assessment was not a comprehensive inventory of stock tanks and dams; rather the focus was on visiting those sites that had—based on observation by ranchers and County staff—the greatest likelihood of holding surface water in the foresummer.
- Springs. These are areas where groundwater discharges above the ground surface and mostly outside of a streambed or channel. Most of the springs referenced here are hillside springs, but can also include limnocrene springs (Springer and Stevens 2008) and three rheocrene springs that are only known to express very small amounts of water. As with stock tanks and dams, not all springs were visited. For example, Becky Spring (Bar-V Ranch) is a hillside spring, but is boxed and piped to the Bar-V ranch house. There are other hillside spring sites across County lands with moist soil, calcium carbonate deposits, and/or history of surface expression that were not visited during these surveys because it was determined that they would be unlikely to express surface water. The spring at Bingham Cienega is a particularly notable example.



Figure 1. Surface water features on County conservation lands include springs (A; Blacktail Spring, Sands Ranch), stock tanks and dams (B; Hopkins Tank, Rancho Seco), and stream reaches (C; Cienega Creek), which includes tinajas (D; Espiritu Canyon, A7 Ranch) and some springs.

- Streams. Anywhere where water emerges in a streambed and (typically) flows for some distance. Most rheocrene springs (Springer and Stevens 2008), where water emerges from bedrock or where shallow groundwater intersects the surface, are also included, as are tinajas (bedrock pools) that are fed from either groundwater or precipitation (via runoff).

All surveys took place between late May and early July each year. Characteristics recorded at sites included the presence of water and its location (UTM, NAD83 using a hand-held GPS receiver). Where pooled water was found (all feature types), data were recorded as a single point feature and (in most cases) the surface area (m²) estimated¹.

For surveys along streams, observers recorded the survey beginning and end locations and the beginning and end of surface water segments (flowing or standing water) that were

¹ Data are not summarized in this report.

approximately >3m in length. The beginning of a flowing segment was always the upstream point, regardless of whether the observer was walking upstream or downstream to conduct the survey; this was important for data management. This report also summarizes stream flow length data collected by Pima Association of Governments (PAG) staff at the Cienega Creek Natural Preserve.

Point features (primarily pools and recorded as such) along streams were generally <3 m in length². These features were not measured using the GPS units because the accuracy (i.e., error) of the units precluded accurate recording of the linear length of these features. Observers also noted the presence—and in some cases numbers—of aquatic or semi-aquatic vertebrates³: fishes (Gila topminnow, Gila chub, and longfin dace), lowland and Chiricahua leopard frogs, canyon tree frog, Sonoran mud turtle, and black-necked garter snakes. Photographs were occasionally taken, but was not a required element of the protocol.

Monitoring was undertaken by staff from three County departments: Office of Sustainability and Conservation; Natural Resources, Parks and Recreation; and Regional Flood Control District and with assistance from the Pima Association of Governments at Cienega Creek and Davidson Canyon.

Data Management. Source data for Cienega Creek and Davidson Canyon were provided by PAG as shapefiles whose features referenced various depictions of stream centerlines depending on survey date. Data from County staff were provided as GPS-collected coordinates for survey start and stop points, wet reach start and stop points, and in-channel point features. All features and positions were transferred to a linear referencing system dependent on High Resolution National Hydrography Dataset stream centerlines. A linear referencing data model allows all stream channel features to be stored as table records, which in turn reference a *single* GIS representation of a stream centerline. Linear referencing also affords linear overlay analysis. Both automated GIS tools and manual interpretation were used to create linear referencing table measures for all in-channel features. Stock tanks, dams, and springs were directly mapped according from GPS coordinates.

Pairs of measures which describe wet reaches and survey extents are called *events*. For each stream, all events by type were intersected against each other to create new linear features for both number of times a reach was surveyed and number times flowing water was observed. Finally, tallied surveys and wet reaches were intersected to yield a flow permanence layer. For example, if a reach was surveyed three times and water was present twice, the permanence value is 66%. All event tables and intersect results are stored in an

² PAG staff follow a slightly different protocol and do not collect data on small pools:

<https://www.pagnet.org/documents/water/20FtRuleGuide-2017-01-Draft.pdf>

³ Data are not summarized in this report.

enterprise geodatabase, which allows for data backups, point-in-time recovery, and multi-user editing.

Results

Stock Tanks and Dams

Staff visited 29 stock tanks and dams located on 10 properties in five years of surveys (2011, 2014-2017; Appendix A) for a total of 55 observations (Table 1). The number of visits to sites varied significantly among years and no site was visited in all years. When all visits were considered, surface water was present more times (n = 33) than sites were observed dry (n = 22). Only five sites were wet in each of two or more visits. Six sites varied between wet and dry conditions and three sites visited in two or more years were dry on all visits. There is also considerable geographic variation in the number and density of sites (Appendix A) and wet/dry condition (Table 1) by property and watershed. For example, in the Altar watershed, most stock tanks and dams were on Rancho Seco and Sopori Ranch and these sites were dry (n = 14) as often as wet (n = 14). By contrast, the sites in the San Pedro watershed were wet (n = 13) more often than dry (n = 3).

Table 1. Presence (wet) or absence (dry) of surface water at stock tanks and dams, Pima County conservation lands, 2011-2017.

Watershed	Property	Site	Year				
			2011	2014	2015	2016	2017
Altar	King 98	NAWA					Dry
		Rancho Seco	Cerro Colorado	Dry			Wet
	Compressor		Dry			Wet	Wet
	Cradle					Wet	Dry
	Honeymoon						Dry
	Hopkins		Wet			Wet	Wet
	Horseshoe						Wet
	Mud					Dry	
	Sopori	Pesquiera	Dry			Wet	
		Papalote	Dry				Dry
		Sparkplug				Dry	Dry
		Steer Pasture	Wet		Dry		Dry
		Cedar Canyon					Dry
	Verdugo	Verdugo			Wet	Wet	Wet
Cienega		Bar V				Wet	Dry
	Clyne	Hospital	Wet	Wet		Wet	
	Sands	Boulder					Dry
		Goat Well					Dry
		MacNally	Wet	Dry		Wet	Dry
San Pedro	A7	Barrow					Wet
		Jerry					Wet
		Bear		Wet			
		Big	Dry			Wet	Wet
		Upper				Wet	Wet
		Youtcy					Wet
		Six Bar	Davis Mesa		Wet		
	Lone Hill						Wet
	Split						Wet
	Tucson Basin	Carpenter	Carpenter Spring				Dry
Unnamed						Wet	Wet

Springs

Staff visited 15 springs on ten County properties for a total of 33 observations (Table 2, Appendix A). Most springs were visited only once or twice, with the exception of Blacktail, Grapevine, and Youtcy 2, which were monitored 4-5 times each. Four sites were dry on each visit while seven sites had water on each visit. No site had an abundance of water; all sites with some surface water had either a trickle of running water (or associated small pool) or multiple small pools. Like with stock tanks and dams, there was considerable difference among watersheds, most notably that there were no known springs on County conservation lands in the Altar Valley. There were no apparent difference in presence or absence of water at springs among the three watersheds where springs occur.

Streams

Thirteen stream reaches were surveyed from 2011-2017 on seven County properties (Table 3; Appendix A, B). Only Cienega Creek, Davidson Canyon, and Youtcy Canyon were surveyed each year and total survey effort varied considerably among years in terms of number of sites (low of four in 2012 and high of 12 in 2017) and in some cases the surveyed distances varied within sites. For some sites (exclusive of Cienega Creek and Davidson Canyon), the beginning and end of surveys varied among years as staff learned more about each site.

Cienega Creek had the greatest length of surface water (0.9-1.5 miles) followed by Buehman Canyon (0.1-0.3 miles). No water was found at either Agua Verde or Geesaman washes, though survey effort was only one and two years, respectively. Most stream reaches were in the San Pedro watershed. Appendix B includes maps of survey effort and where water was observed.

Table 2. Presence (wet) or absence (dry) of surface water at springs, Pima County conservation lands, 2011-2107.

Watershed	Property	Site	Year					
			2011	2012	2014	2015	2016	2017
Cienega	Bar V Ranch	Cliff					Dry	Wet
		Mescal					Dry	
	Clyne Ranch	Turney						Wet
	Sands Ranch	Blacktail	Wet		Wet		Wet	Wet
San Pedro	A7	Unnamed			Dry			
		Grapevine	Wet		Wet		Wet	Wet
		Youtcy 2		Wet	Wet	Dry	Wet	Wet
	M Diamond	Homestead					Dry	Dry
		Peck			Wet			Wet
	Six Bar Ranch	Parker Homestead ¹	Dry					
Tucson Basin	Agua Caliente	Agua Caliente Spring					Wet	Wet
	Carpenter	Cochie ¹			Dry	Dry		
		Cottonwood Canyon ¹					Wet	Wet
	Tortolita	Tennis Spring					Wet	Wet
	Rancho Fundoshi	Fundoshi Spring					Wet	Dry

¹ These springs primarily express in drainage bottoms and so are considered rheochrene springs. However, these are very discrete sites and the larger drainage was not surveyed for surface water, as was done for streams.

Unsupplemented Surface Water on Pima County Conservation Lands, 2011-2017

Table 3. Results of stream surveys on Pima County conservation lands, 2011-2017. Data represented: miles of survey effort (Srv), miles of stream with water (wet), and number of pools (P). Pools were not recorded as part of the survey effort at Davidson Canyon or Cienega Creek.

Water-shed	Property	Site	2011			2012			2013			2014			2015			2016			2017		
			Srv	Wet	P	Srv	Wet	P	Srv	Wet	P	Srv	Wet	P	Srv	Wet	P	Srv	Wet	P	Srv	Wet	P
Altar	Rancho Seco	Sparkplug												0.1	0	1	0.1	0.1		0.1	0.1	3	
Cienega	Agua Verde	Agua Verde																		0.9	0		
	Cienega Creek NP	Cienega	9.4	1.3	NA	9.4	1.2	NA	9.4	0.9	NA	9.4	0.9	NA	9.4	0.9	NA	9.4	1.9	NA	9.4	1.5	NA
	Bar-V	Davidson	3.6	0	NA	3.6	0.004	NA	3.6	0	NA	3.6	0	NA	3.6	0	NA	3.6	0.03	NA	3.6	0.1	NA
San Pedro	Buehman Canyon	Buehman	5.5	0.3	4							4.8	0.2	9	5.3	0.2	19	7.2	0.2	28	5.8	0.1	38
		Bullock	0.8	0	1							0.9	0	1	0.9	0.1	1	0.9	0.1	2	0.9	0.04	4
	Oracle Ridge	Gibb tributary	0.3	0.03	2													0.1	0	2	0.3	0.3	
		Geesaman	0.4	0	2										0.5	0							
A7		Edgar							0.4	0.1	2	0.4	0.1	4	1.4	0.1	3	0.5	0.1	3	0.2	0.1	6
		Espiritu	0.9	0	2	0.4	0	1	0.9	0	1	0.1	0	1				3.5	0	3	1.5	0	11
		Youtcy	2.4	0.1	7	1.8	0.1	2	2.4	0	3	0.3	0	1	0.7	0.3	7	2.6	0.5	7	0.7	0.5	2
		Robles	1.0	0	1										1.0	0.03		1.0	0.04		0.2		3
		Soza	0.6	0														0.6	0	1	0.6	0	3
Total Survey Distance (miles)			24.9			15.2			16.7			19.7			22.8			29.5			24.1		

Discussion

This report summarizes 145 visits to 58 sites, thereby representing a significant increase in our knowledge of the status of surface water on County conservation lands. Though there has been a marked increase in field effort since 2011—and even the discovery of previously unknown persistent surface water features—the fundamental conclusion of the 2011 report remains: surface water is a rare resource on County conservation lands in the arid foresummer season (Table 1-3). For example, of the 58 tanks, spring, and stream sites visited at least once, 42 had surface water in at least one year, but only 20 sites (5 tanks, 6 springs, and 9 streams) with two or more visits had surface water present on each visit.

Protection and enhancement of unsupplemented surface water sources (particularly perennial streams, springs, and tinajas) was repeatedly stated to be a top management priority during the development of the SDCP (Pima County 2000a). As compared to supplemented surface water, unsupplemented features often require fewer resource inputs (e.g., time, materials) to keep a site functional as a surface water feature. However, reliance on natural processes (rainfall, runoff, recharge) to supply water can be problematic; as the data reported here clearly show (Tables 1-3, Appendix B), water permanence is not assured and can be highly variable.

While the focus of this report is to identify sites that hold water longest during the foresummer, intermittent or ephemeral surface water features also have value. Intermittent and ephemeral waters play a critical role in a host of ecosystem functions such as dispersal of aquatic animals, nutrient and carbon cycling, infiltration and recharge to support downstream perennial waters and hyporheic zones, flood attenuation, and sediment movement (Levick et al. 2008). Many formerly perennial waters in Pima County are now intermittent or ephemeral (Pima County 2000b, 2002) and some of these areas are the focus of current restoration efforts, such as the Watershed Management Group's work along Sabino, Tanque Verde, and Agua Caliente washes. These areas can be crucial resources for a wide range of resources and needs such as wildlife, livestock, and human recreation and enjoyment.

Management Implications

Data in this report are a crucial first step in the inventory and assessment of surface water features on county conservation lands. These data can have a variety of uses, from predictions about the impacts of site conditions moving from perennial to intermittent or ephemeral on important conservation targets such as vegetation (Lite and Stromberg 2005), to providing a framework for management actions. In particular, these data can provide a critical tool in the assessment of whether some of these sites should receive supplemental water or whether building other, human-constructed surface water features should be undertaken in areas with less reliable foresummer surface water. Pima County has constructed at least five wildlife water projects (i.e., supplemented water sources where livestock are excluded) in the last few years alone. Site-specific data from this effort has also informed the County's surface water rights as part of the Gila River Adjudication. Other

management actions could include enhancing surface water for greater water-holding capacity (e.g., at stock tanks) and improving upland conditions that ultimately impact downstream surface water resources.

Development of County management plans. The importance of unsupplemented surface water in our region cannot be overstated and its rarity is supported by the data in this report. Therefore, these data will be valuable in for the following management planning processes:

- The *Aquatic and Riparian Species Management Plan* is an important element of the MSCP and must be completed by July 2019. The plan will focus primarily on natural and artificial surface water sites to promote covered species occupancy where feasible and prudent. The plan will include detailed summaries of each sites regarding surface water extent and permanence.
- *Property-specific management plans* will be developed throughout the 30 years of the County's MSCP; these management plans will be focused on a host of key resources and water will play an important role in the process. The County is currently developing a management plan for Bingham Cienega Natural Preserve.
- *Coordinated Resource Management plans* support grazing on County ranches. Because of the importance of water resources for cattle and the need for the County to balance cattle grazing operations with natural resource protection, data in this report will help inform these inter-agency planning efforts.

Data Limitations and Uses

Surveys were carried out in the driest time of year when surface water extent and presence is the annual minimum extent and therefore does not represent the breadth of condition that might be found at other times of year. For example, Powell (2013) summarized streamflow length at Cienega Creek through 2011 and found that December streamflow extent was 22-60% longer than the June survey of the same year. Similarly, this report summarizes water extent from 2011-2017, a period of significant and sustained drought (Figure 3) and does not take into account the full breadth of year-to-year variations that might be evident in a longer dataset (e.g., Powell 2013).

It is also important to note that the data summarized in this report is not sufficient to establish trends in surface water except at a few sites (e.g., Cienega Creek and Davidson Canyon) that have a longer history of monitoring. Analysis of trends can be done only after more data are collected and the increase in field effort in 2016 and 2017 (Tables 1-3) provides a solid foundation for future trend assessments.

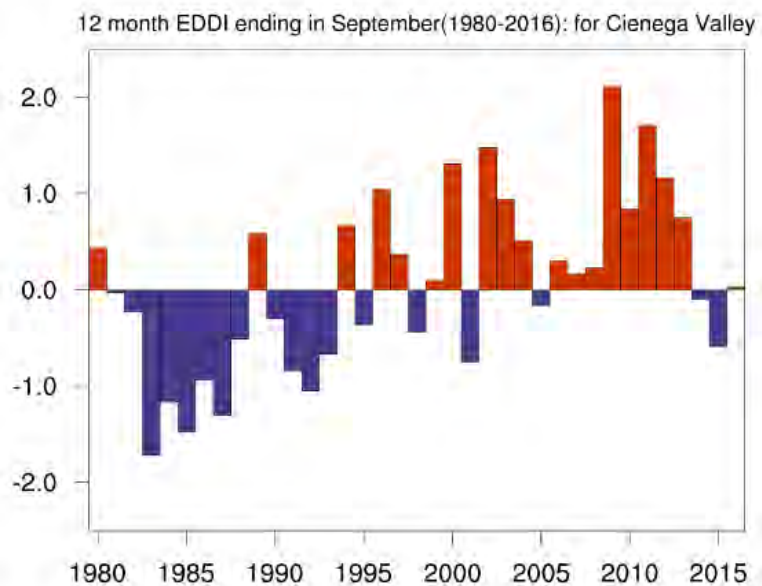


Figure 3. Evaporative Demand Drought Index from 1979-2017 for the Tucson Basin showing drought conditions in red. Drought condition during the study period (2011-2017) has been particularly severe. From Hobbins et al. (2016).

Recommendations

Despite having collected data about surface water for seven years, the County is just beginning to understand this key resource. Below are recommendations for future work to continue the inventory, monitoring, and assessment of unsupplemented perennial surface water on County conservation lands.

- 1) Search for previously unknown features. Despite hundreds of hours of inventory work on County conservation lands, staff continue to document previously unknown features. These inventory efforts should continue.
- 2) Continue pre-monsoon monitoring of key sites and refine the monitoring protocol. The annual foresummer (“wet/dry”) effort that produced these data should continue with some modifications. First, the emphasis each year should be on visiting sites that have been shown to be perennial or near perennial. Sites with intermittent surface water should also be monitored, but because of the considerable time commitment needed to visit all potential sites, an alternative sampling design should be considered, for example visiting these sites every other year (or when a rainfall trigger has been met) or together with monitoring commitments associated with specific MSCP covered species. Other protocol modifications should include surveying between the same stretch of stream reach on each visit (i.e., standardizing survey reaches), taking more accurate measurement of surface water area (stock tank and dams and springs), and measuring core water-quality measures (e.g., temperature, pH, oxygen) where appropriate. Because the current survey reaches of streams is dictated by the minimal extent of flow as a result of decades of drought,

special attention will need to be directed to increasing the length of surveys during particularly wet years.

- 3) Standardize site names. Confucius wrote: “The beginning of wisdom is to call things by their proper name.” Some of the sites referenced in this report do not have standardized names and are therefore referenced differently by County staff and cooperators. Having a single database of sites with standardized names will be critical first step in monitoring and managing these resources. Fortunately, the County is developing an integrated database of water features and the rapid implementation of that system should be a top priority for the County (see #4, below).
- 4) Integrate data into an online database. The County is moving towards serving up these data to a web platform (PimaMaps) where data summarized for each site could include: a photograph of each site, percentage and dates of visits when surface water was present, and vertebrate species found. This information will be helpful for both managers and to the general public (with more limited access to these data for the public).

Acknowledgements

This project would not have been possible without the help from a host of people who collected data for this effort: Celeste Andresen, Kerry Baldwin, Jess Barry, Alex Binford-Walsh, Carianne Campbell, Don Carter, Mindy Cox, Eric Druv, Julia Fonseca, David Hall, Joe Kellner, Amy Loughner, Rachel Loubeau, Mead Mier, Ian Murray, Andres Piedra, Jacob Prietto, Vanessa Prileson, Marisa Rice, Iris Rodden, Doug Siegel, Madeline Stoll, John Sullivan, Saiyeeda Underwood, and Floyd White. Mike List was an invaluable resource for this report; he took the Microsoft Excel spreadsheet and patiently and adeptly developed a geodatabase using the tools described in the Data Management section (which he also wrote). Mike also produced all the maps in this report. Julia Fonseca and Ian Murray provided excellent feedback on an earlier version of this report.

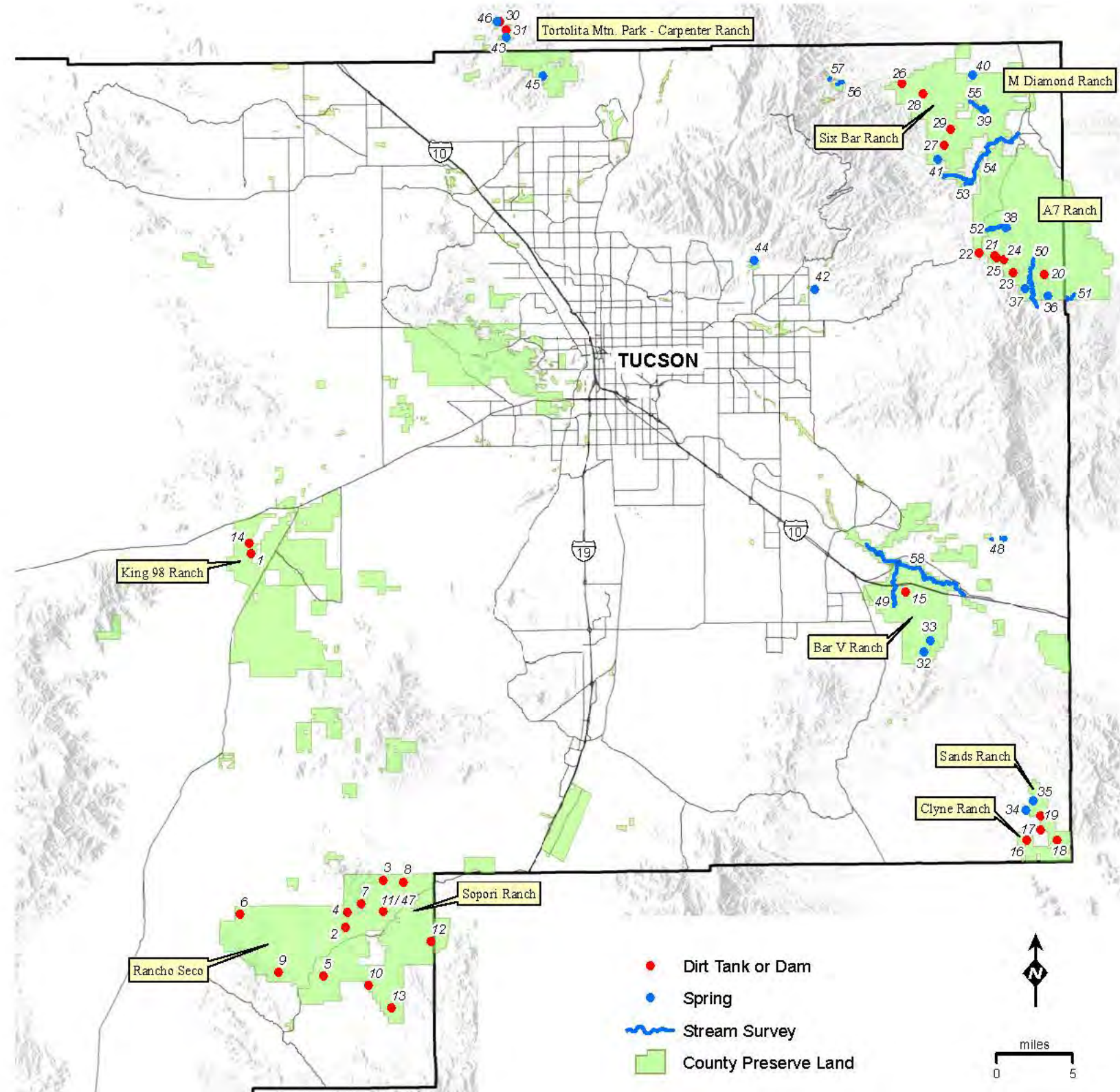
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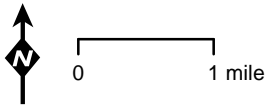
ID	Site Name
1	NAWA
2	Cerro Colorado
3	Compressor
4	Cradle
5	Honeymoon
6	Hopkins
7	Horseshoe
8	Mud
9	Pescada
10	Papalote
11	Sparkplug
12	Steer Pasture
13	Cedar
14	Verdugo
15	Cedar
16	Hospital
17	Boulder
18	Goat Well
19	MacNally
20	Bear
21	Barrow
22	Jerry
23	Big
24	Upper
25	Youtcy
26	Daw's Mesa
27	Lone Hill
28	Split
29	Old Dirt Tank
30	Unnamed
31	Carpenter
32	Cliff
33	Mescal
34	Turney
35	Blacktail
36	Unnamed
37	Grapevine
38	Youtcy2
39	Homestead
40	Peck
41	Parker Homestead
42	Agua Caliente Spring
43	Cochie Spring
44	Fundoshi
45	Tennis Spring
46	Cottonwood Canyon
47	Sparkplug Tank Canyon
48	Agua Verde
49	Dawson
50	Espiritu
51	Robles
52	Youtcy
53	Bullock
54	Buehman
55	Edgar Canyon
56	Geesaman
57	Gibb
58	Cienega



Appendix A. Location of sites with unsupplemented surface water referenced in this report.

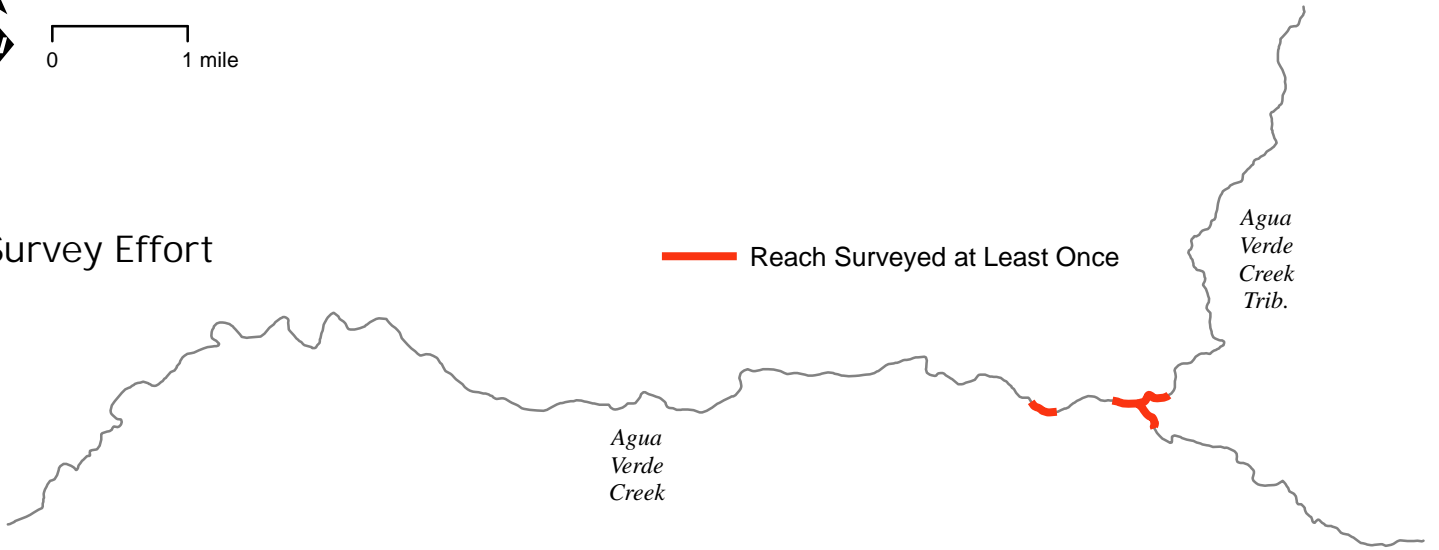
Appendix B. Maps of stream surveyed for surface water on County lands, 2011-2017. For all streams surveyed there is one page with three maps: 1) Survey effort, which is the area surveyed at least once. 2) Areas where flowing water was observed, broken out by categories of the percentage of time that each reach had water. The potential “percent of time wet reach observed” (mapped in four categories: 0-25, 25-50, 50-75, and 75-100) varied by stream (i.e., if a stream was only surveyed once but had a flowing segment, then the “percent of time wet reach observed” would be mapped in the 75-100 percent category, whereas if a stream was surveyed on four or more years, then there is a potential for data to be mapped in each of the four percent categories). 3) Location of mapped pools. If a stream had a flowing segment and/or pools, then those data from the first set of maps are shown on aerial images.

AGUA VERDE CREEK

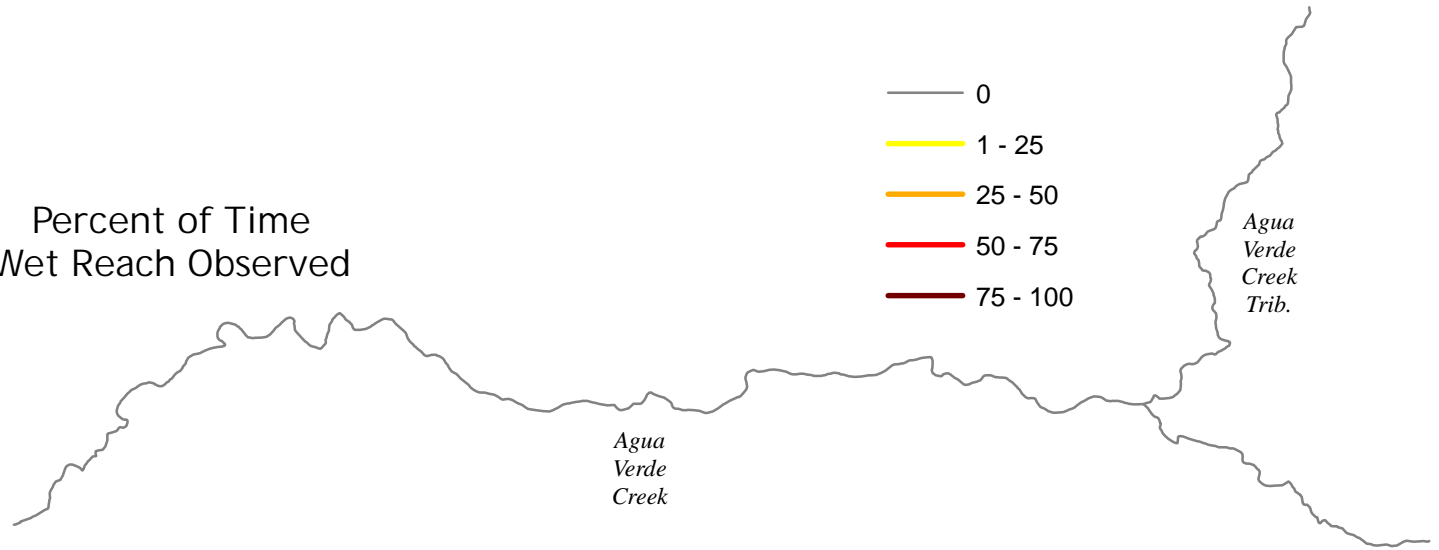


Survey Effort

— Reach Surveyed at Least Once

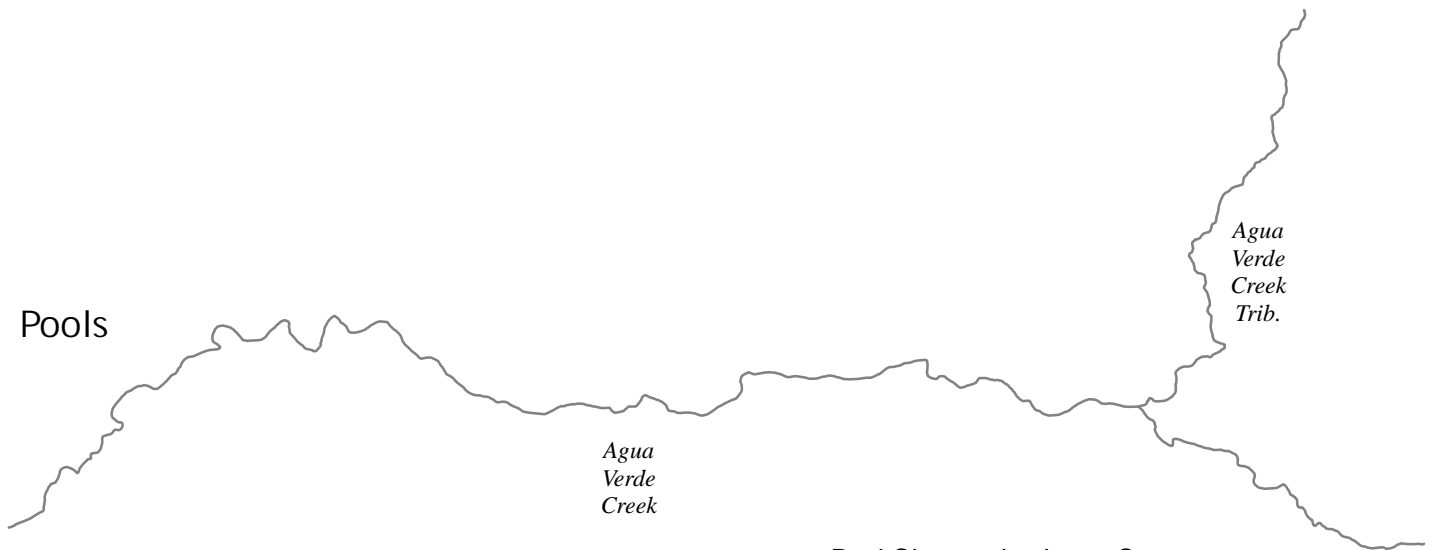


Percent of Time Wet Reach Observed

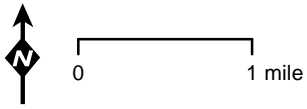


Pools

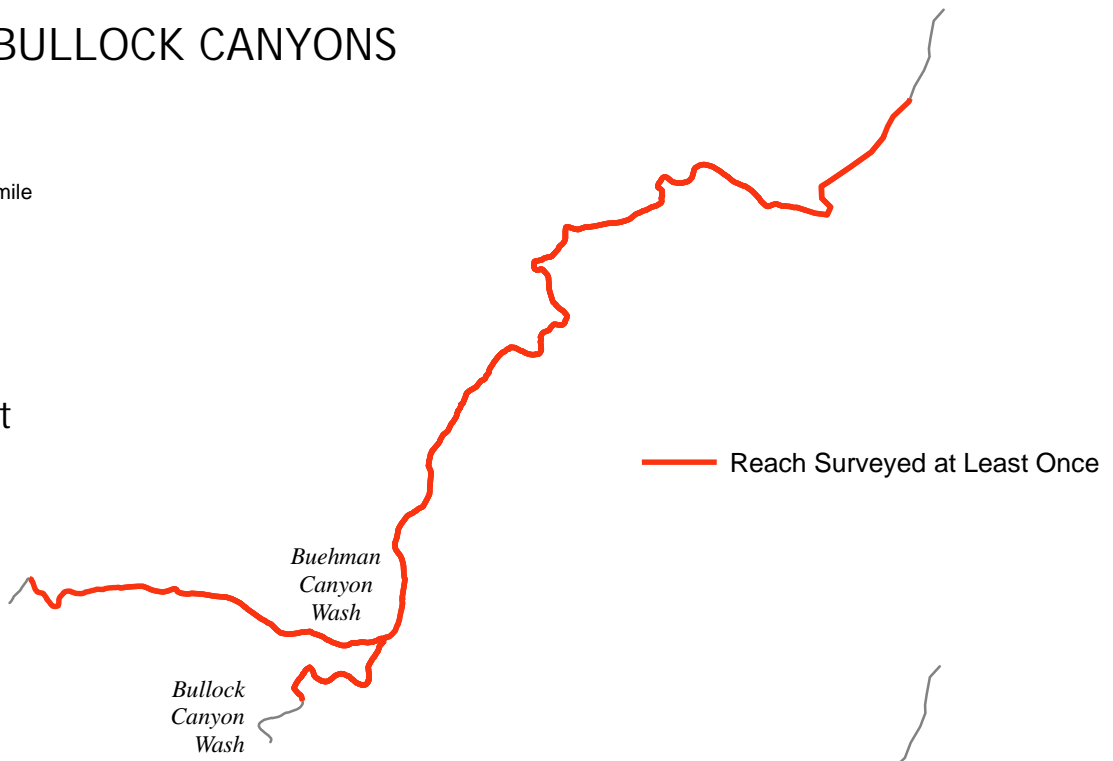
• Pool Observed at Least Once



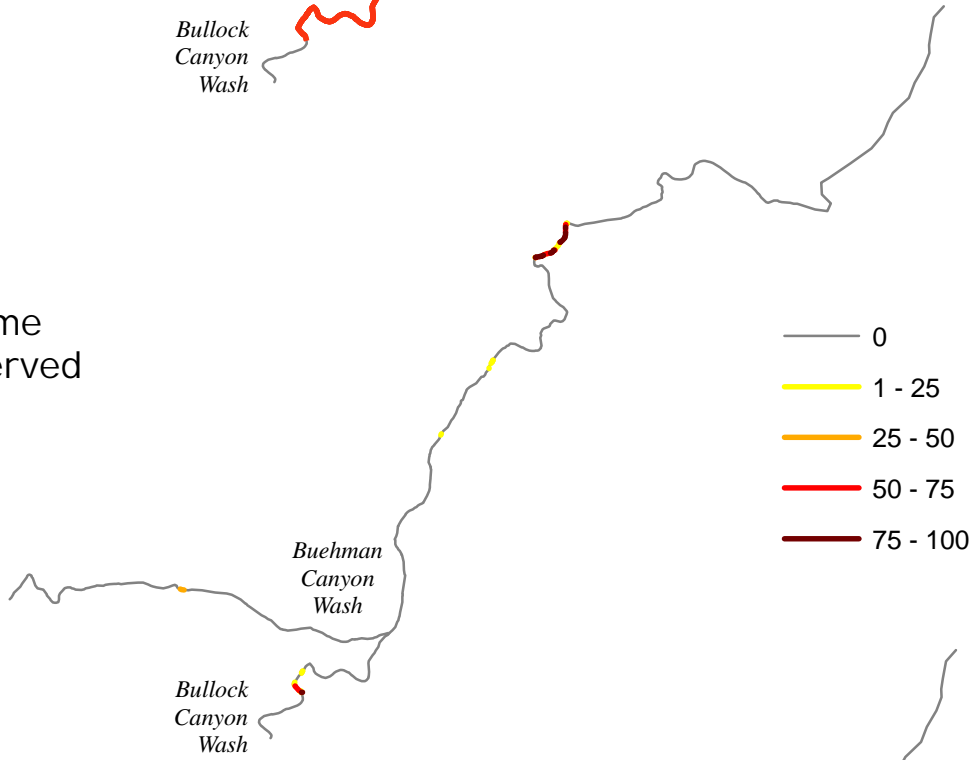
BUEHMAN & BULLOCK CANYONS



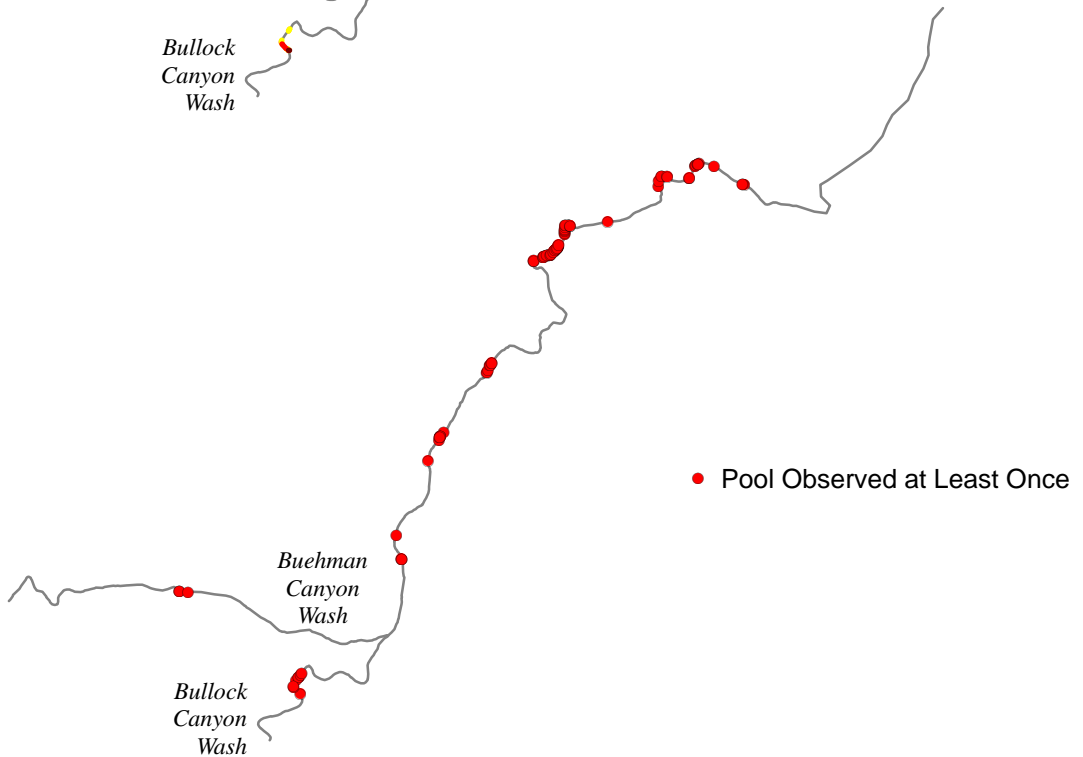
Survey Effort



Percent of Time Wet Reach Observed



Pools



BUEHMAN & BULLOCK CANYONS

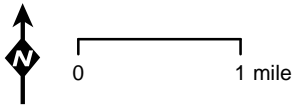


0 1,000 ft

of Wet Reach Observations



CIENEGA CREEK



Survey Effort

— Reach Surveyed at Least Once

Cienega Creek

Percent of Time Wet Reach Observed

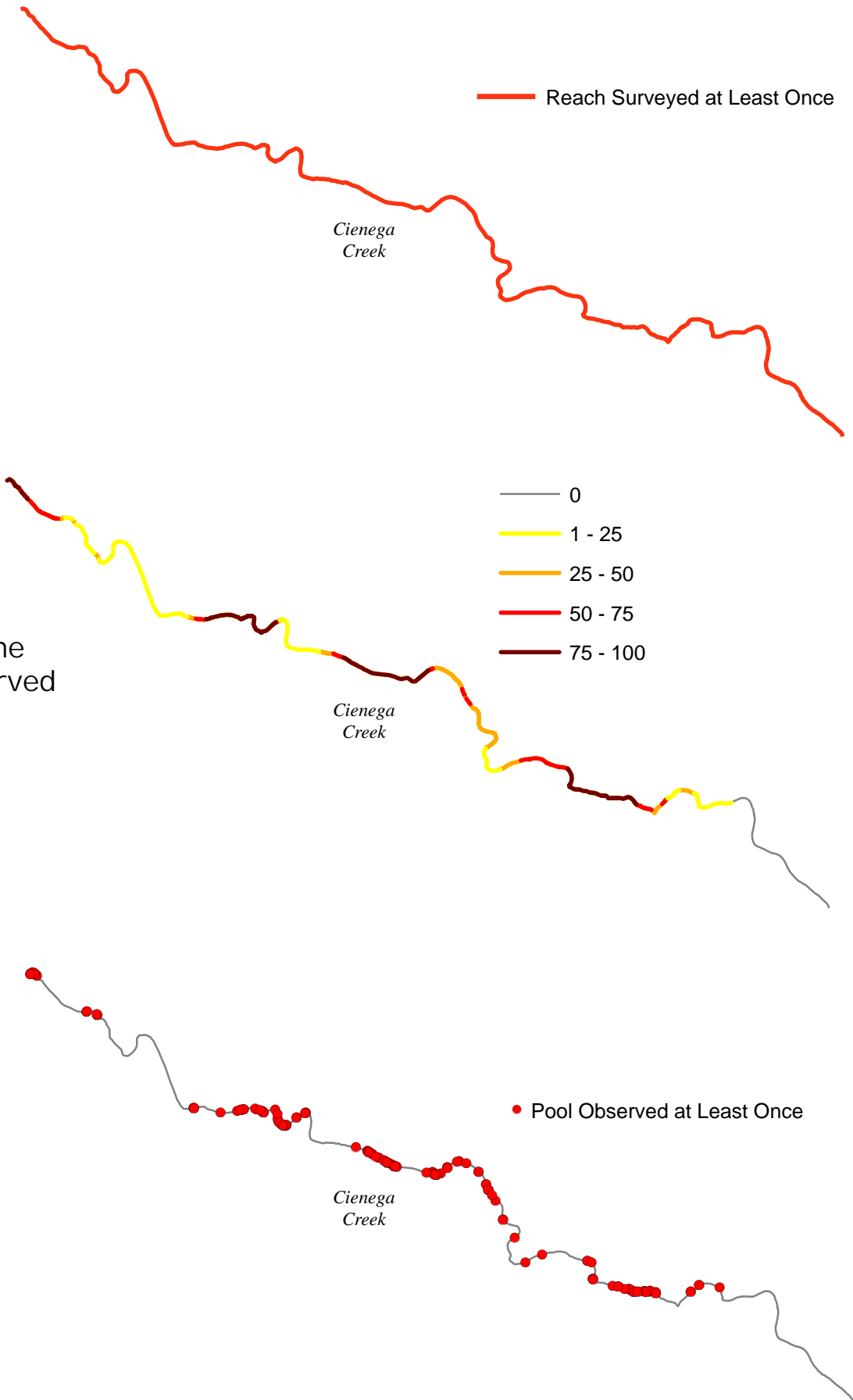


Cienega Creek

Pools

• Pool Observed at Least Once

Cienega Creek



CIENEGA CREEK



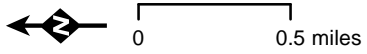
0 2,000 ft

of Wet Reach Observations

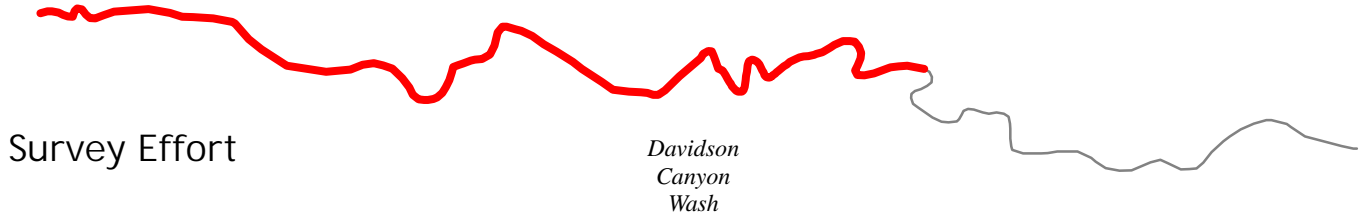
- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 40+



DAVIDSON CANYON



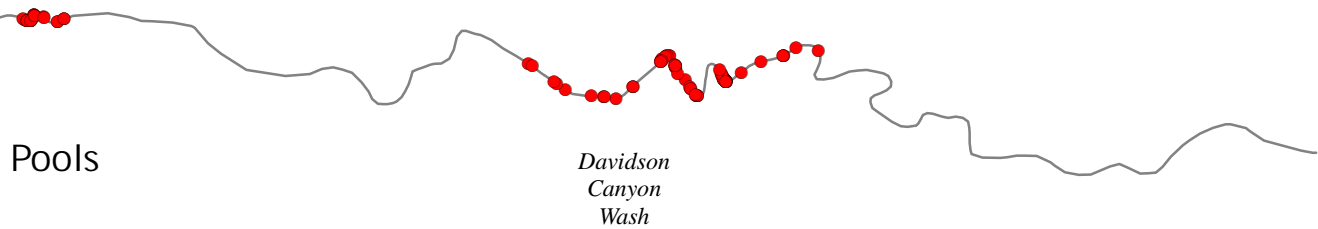
— Reach Surveyed at Least Once



Percent of Time Wet Reach Observed

Davidson Canyon Wash

• Pool Observed at Least Once



DAVIDSON CANYON

of Wet Reach Observations

1 - 5

6 - 10

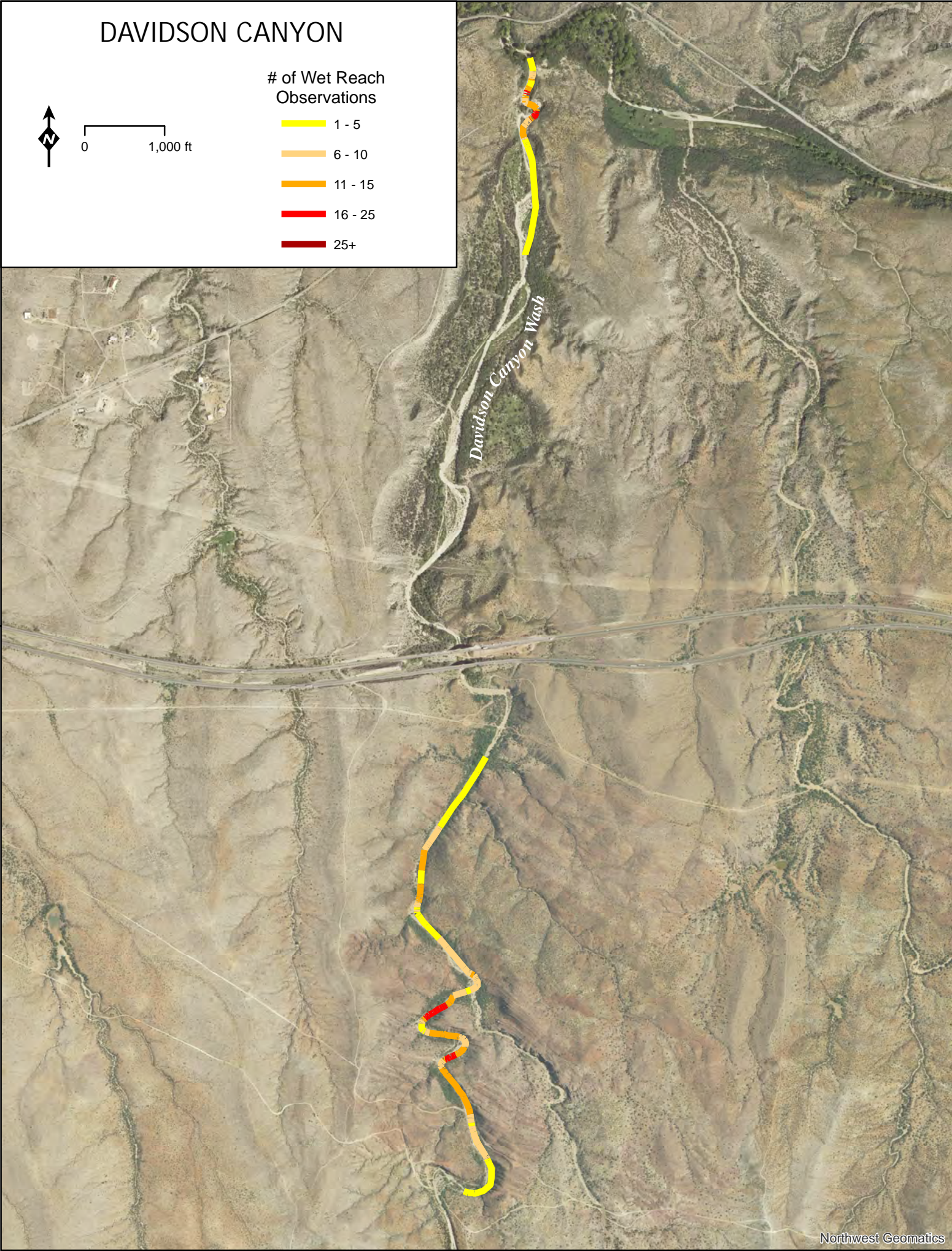
11 - 15

16 - 25

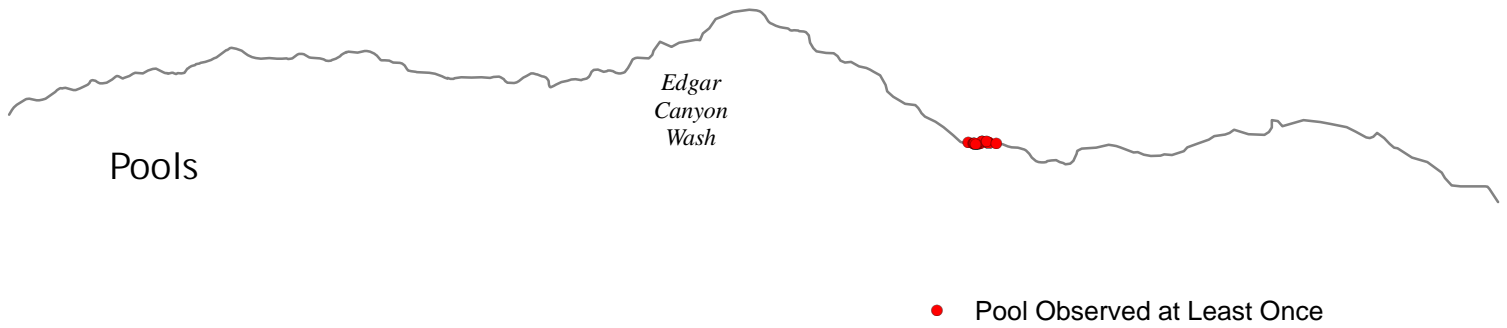
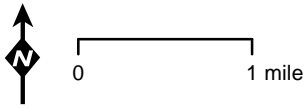
25+



0 1,000 ft



EDGAR CANYON



EDGAR CANYON

of Wet Reach
Observations

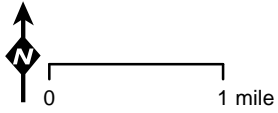


0 1,000 ft

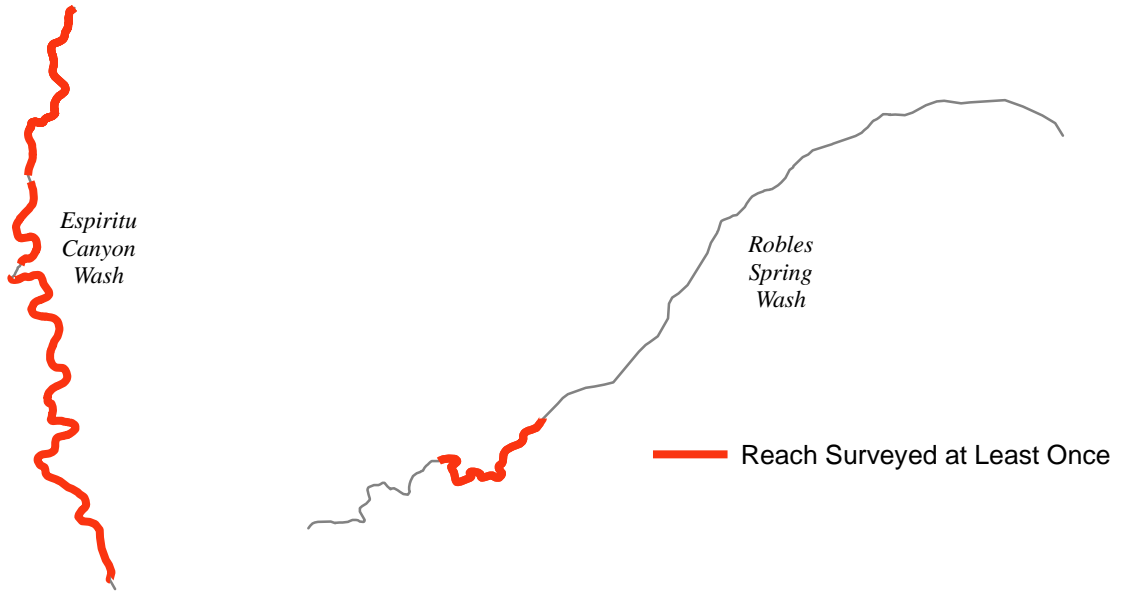


Edgar Canyon Wash

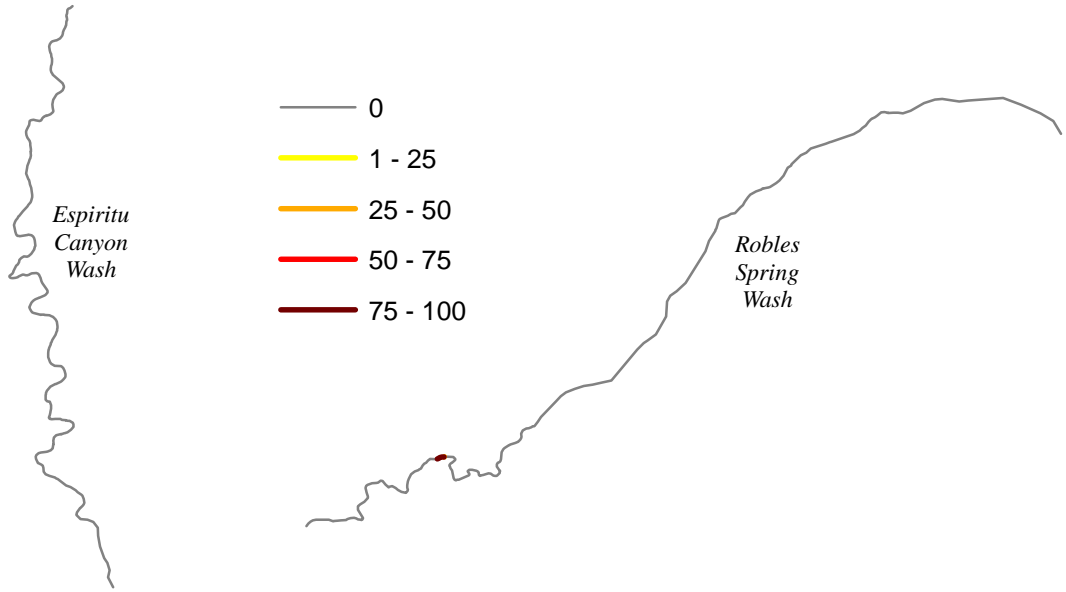
ESPIRITU CANYON & ROBLES SPRING



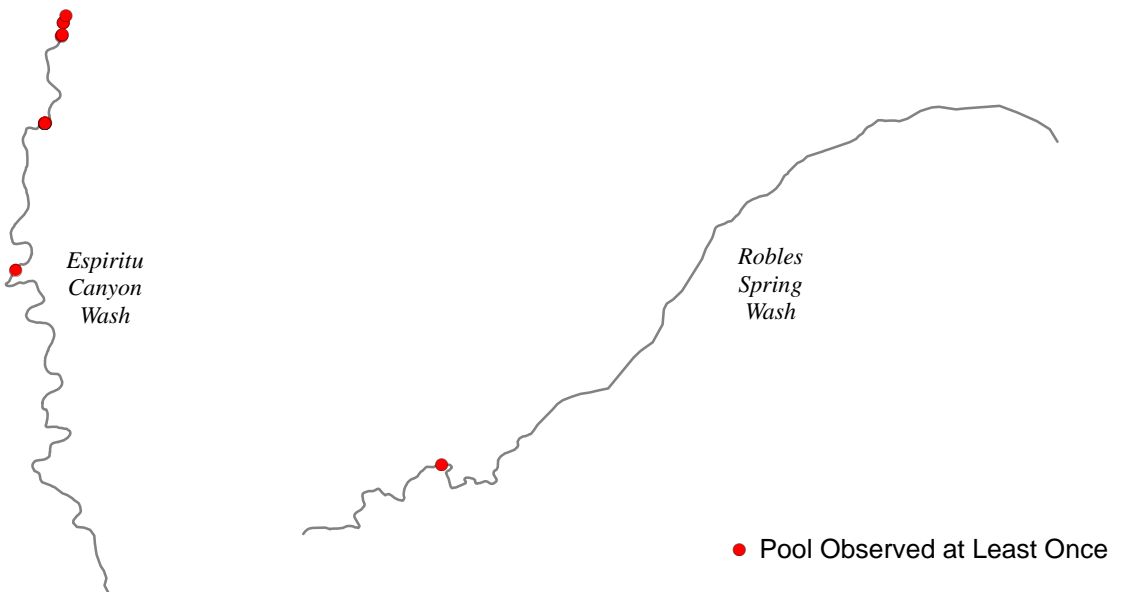
Survey Effort



Percent of Time Wet Reach Observed



Pools



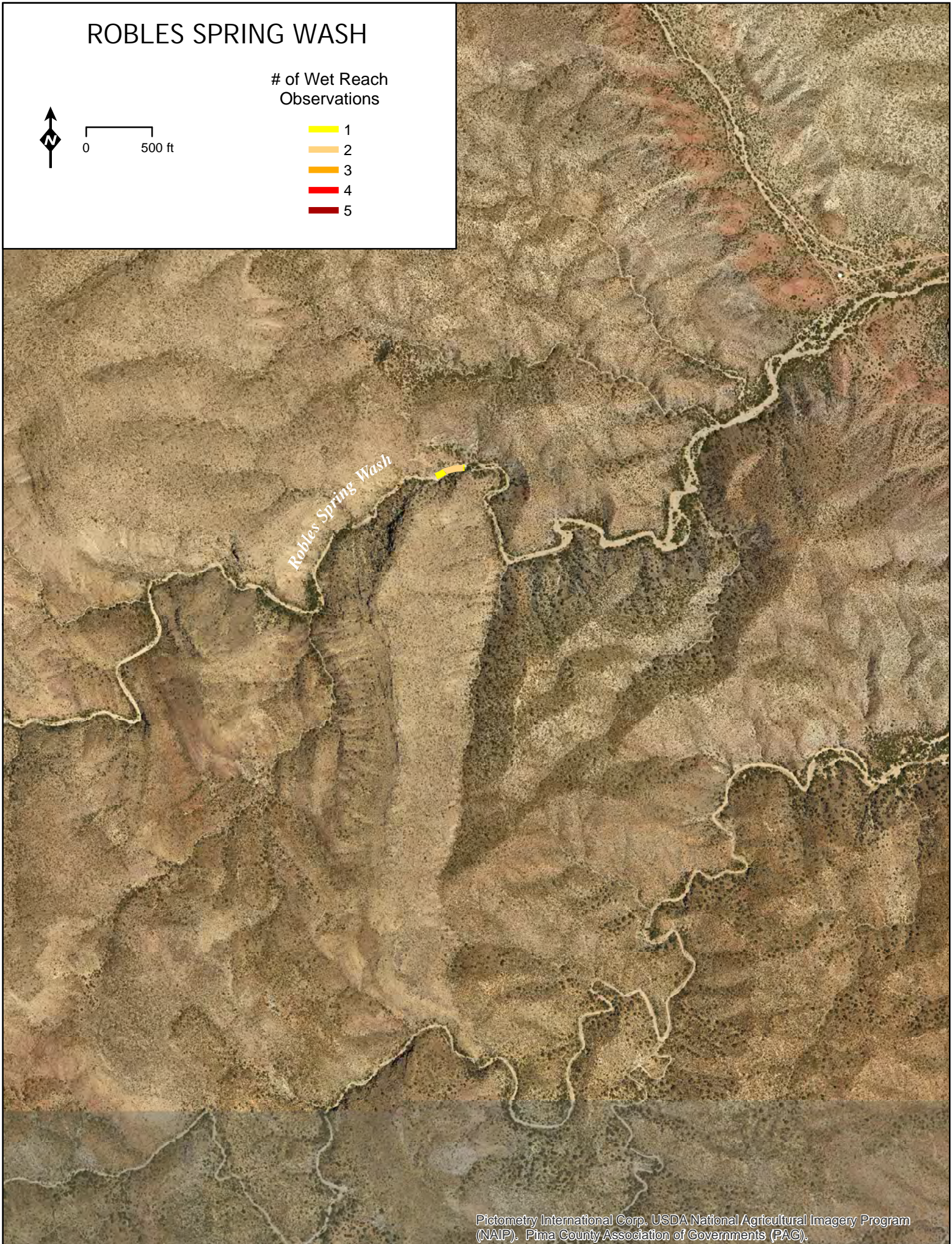
ROBLES SPRING WASH

of Wet Reach
Observations

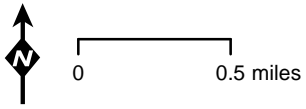


0 500 ft

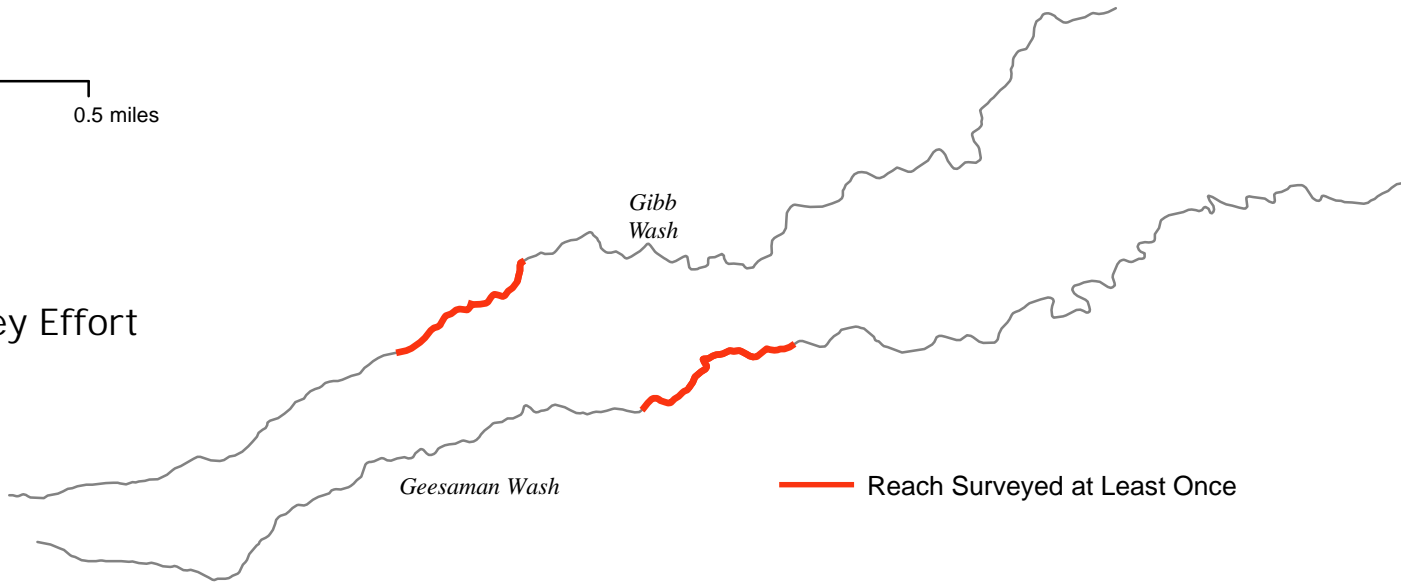
- 1
- 2
- 3
- 4
- 5



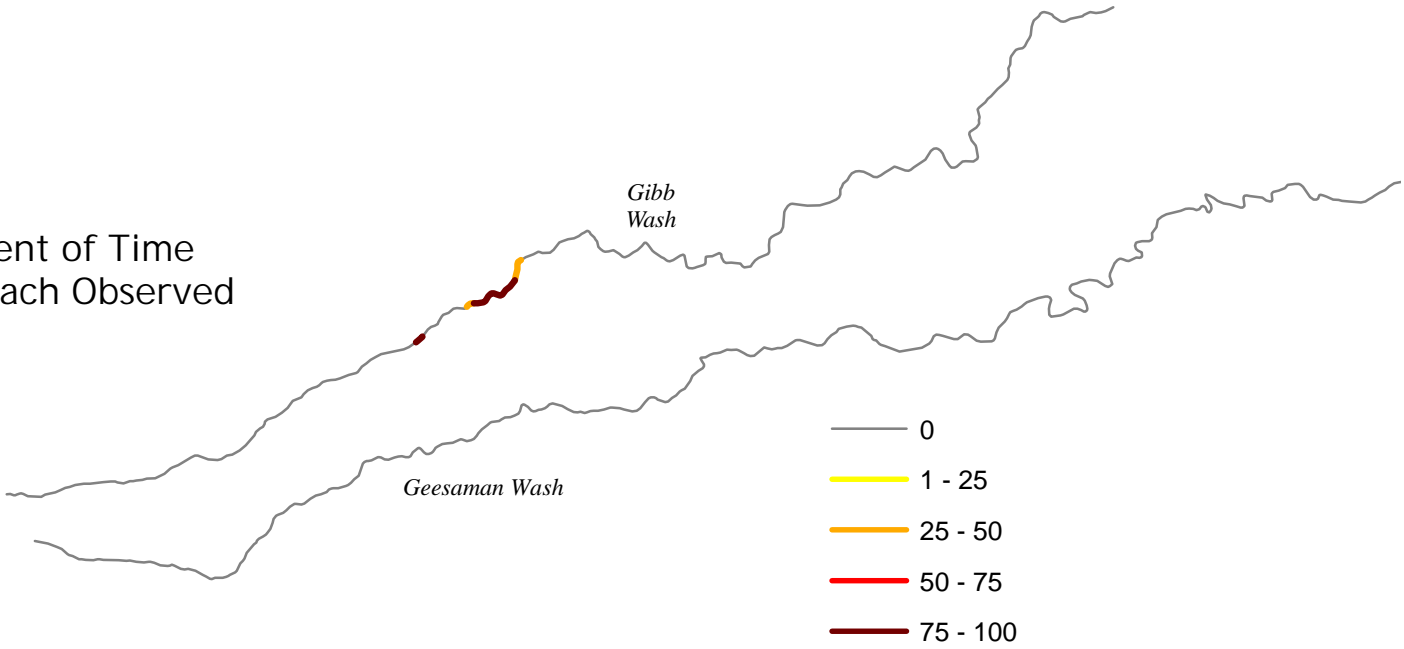
ORACLE RIDGE



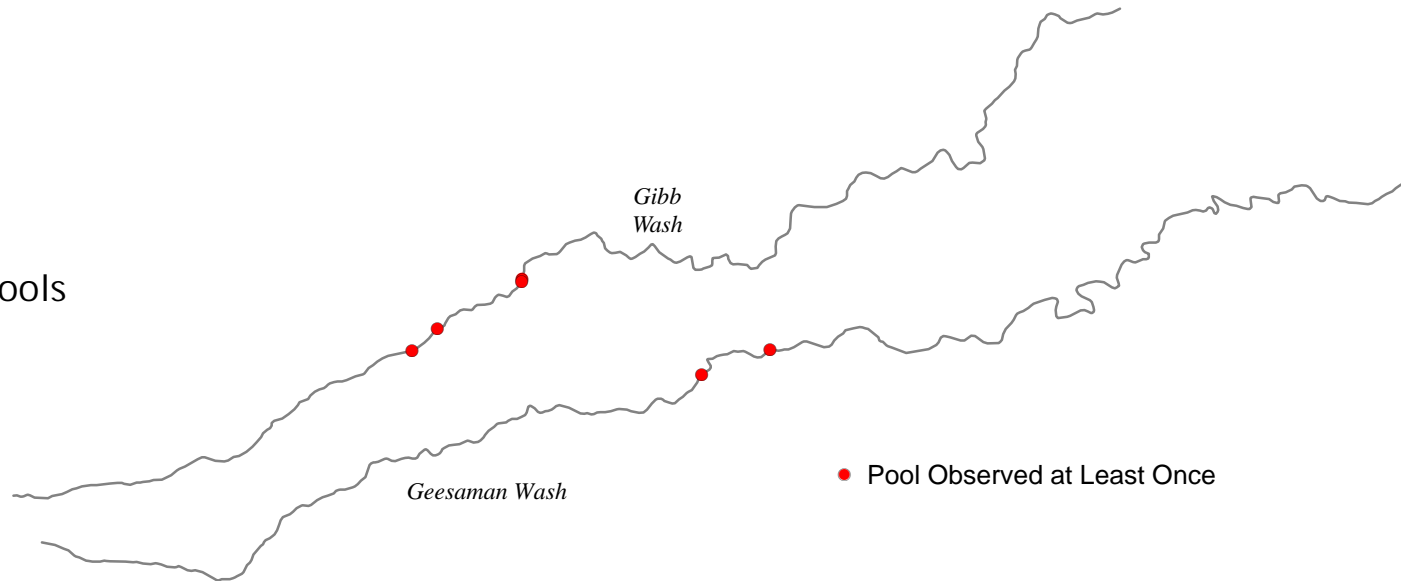
Survey Effort



Percent of Time Wet Reach Observed

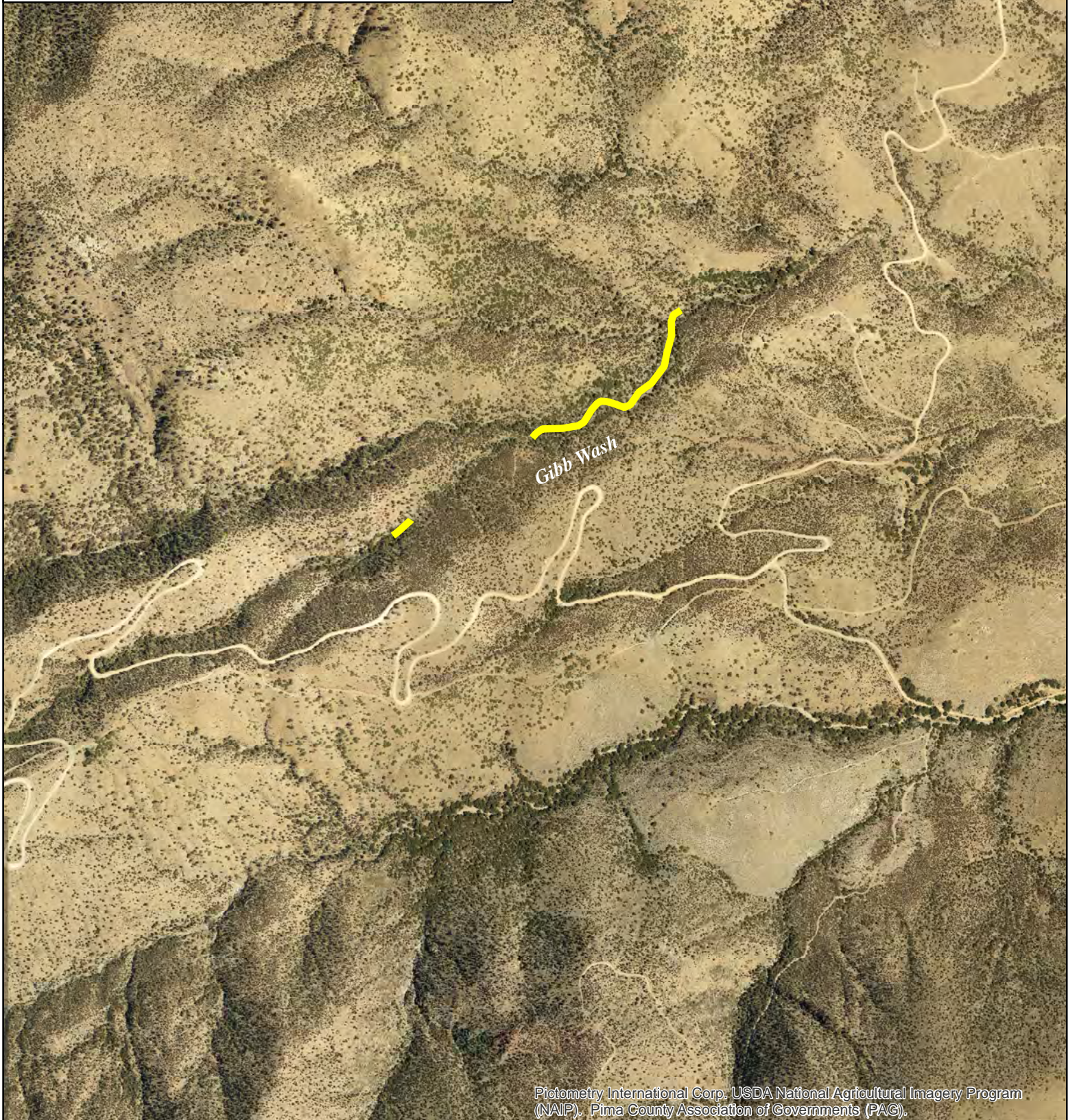
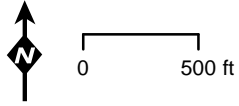


Pools



ORACLE RIDGE

of Wet Reach Observations




SPARKPLUG TANK CANYON



0 0.45 miles

Survey Effort

*Sparkplug
Tank
Canyon
Wash*

 Reach Surveyed at Least Once


Percent of Time
Wet Reach Observed

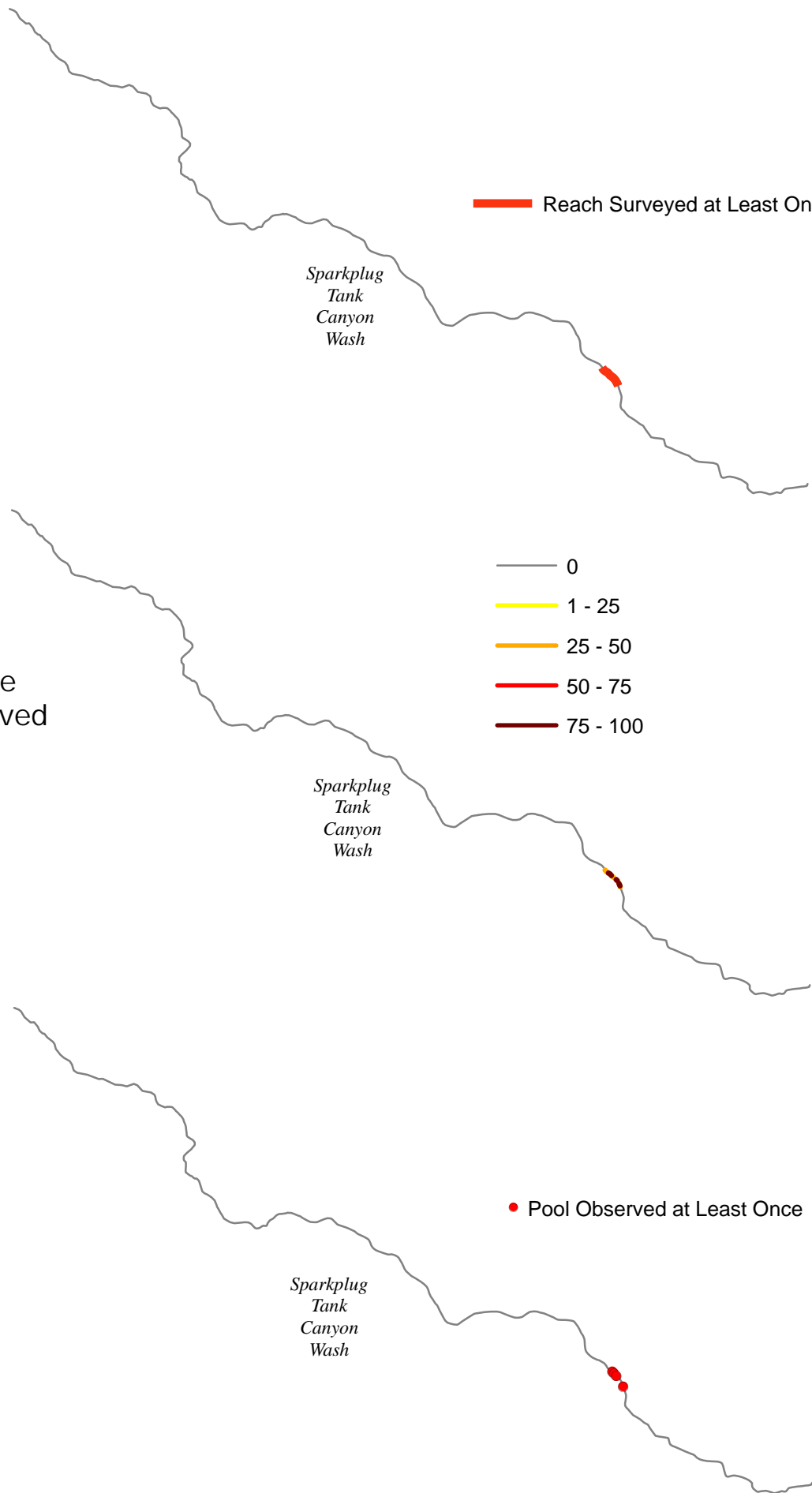
*Sparkplug
Tank
Canyon
Wash*



Pools

*Sparkplug
Tank
Canyon
Wash*

 Pool Observed at Least Once



SPARKPLUG TANK CANYON

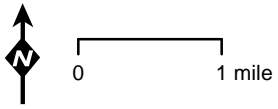
of Wet Reach Observations



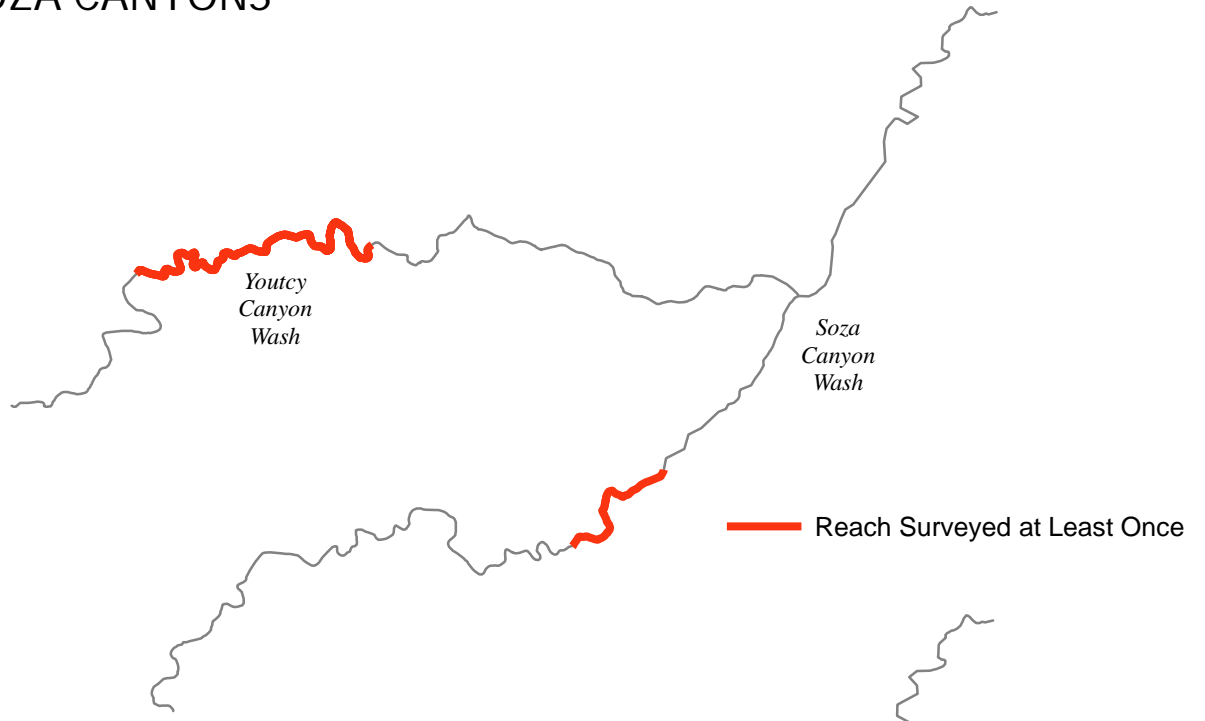
0 500 ft



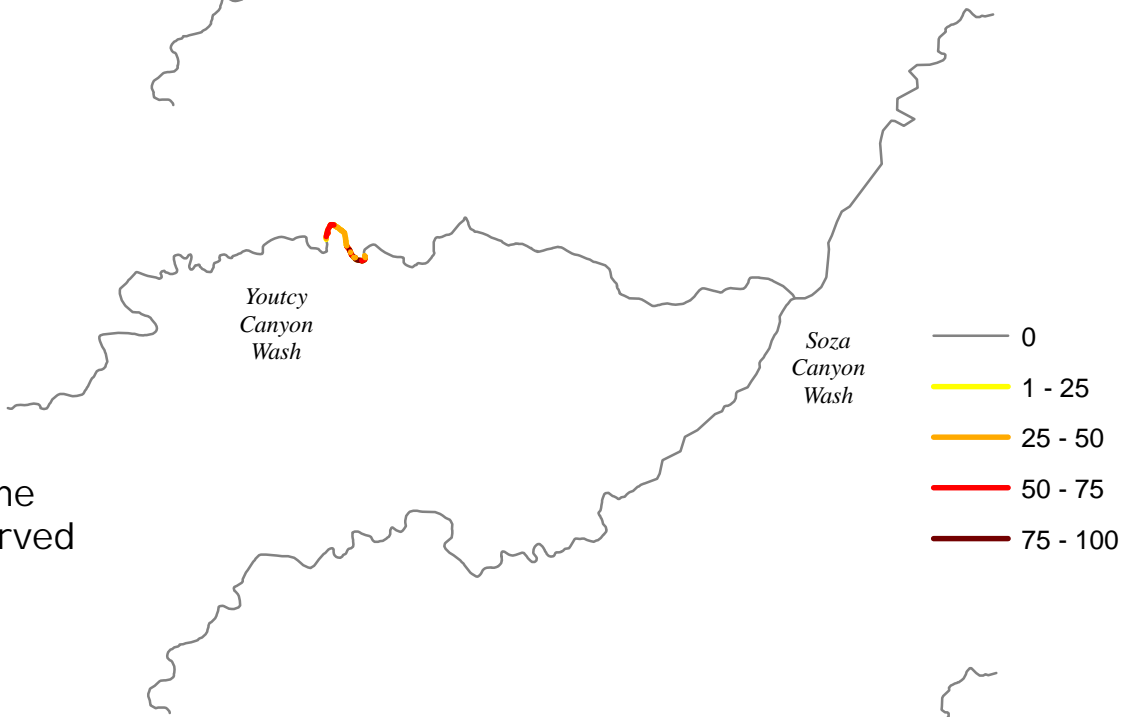
YOUTCY & SOZA CANYONS



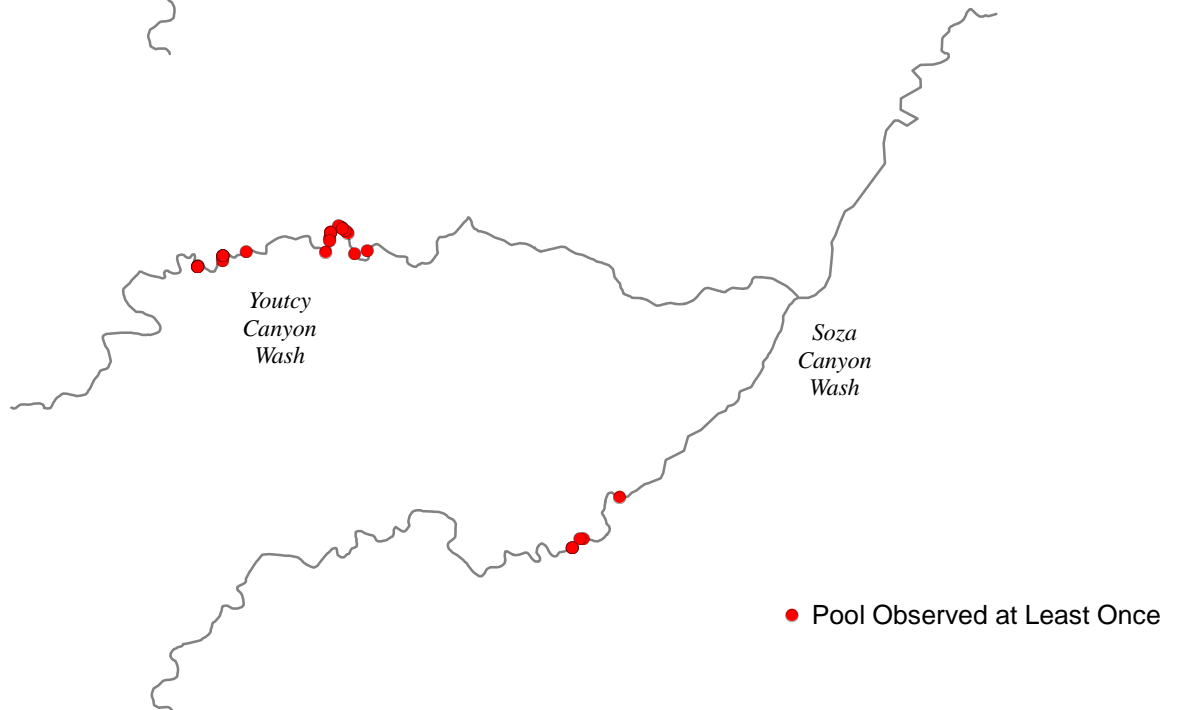
Survey Effort



Percent of Time Wet Reach Observed



Pools



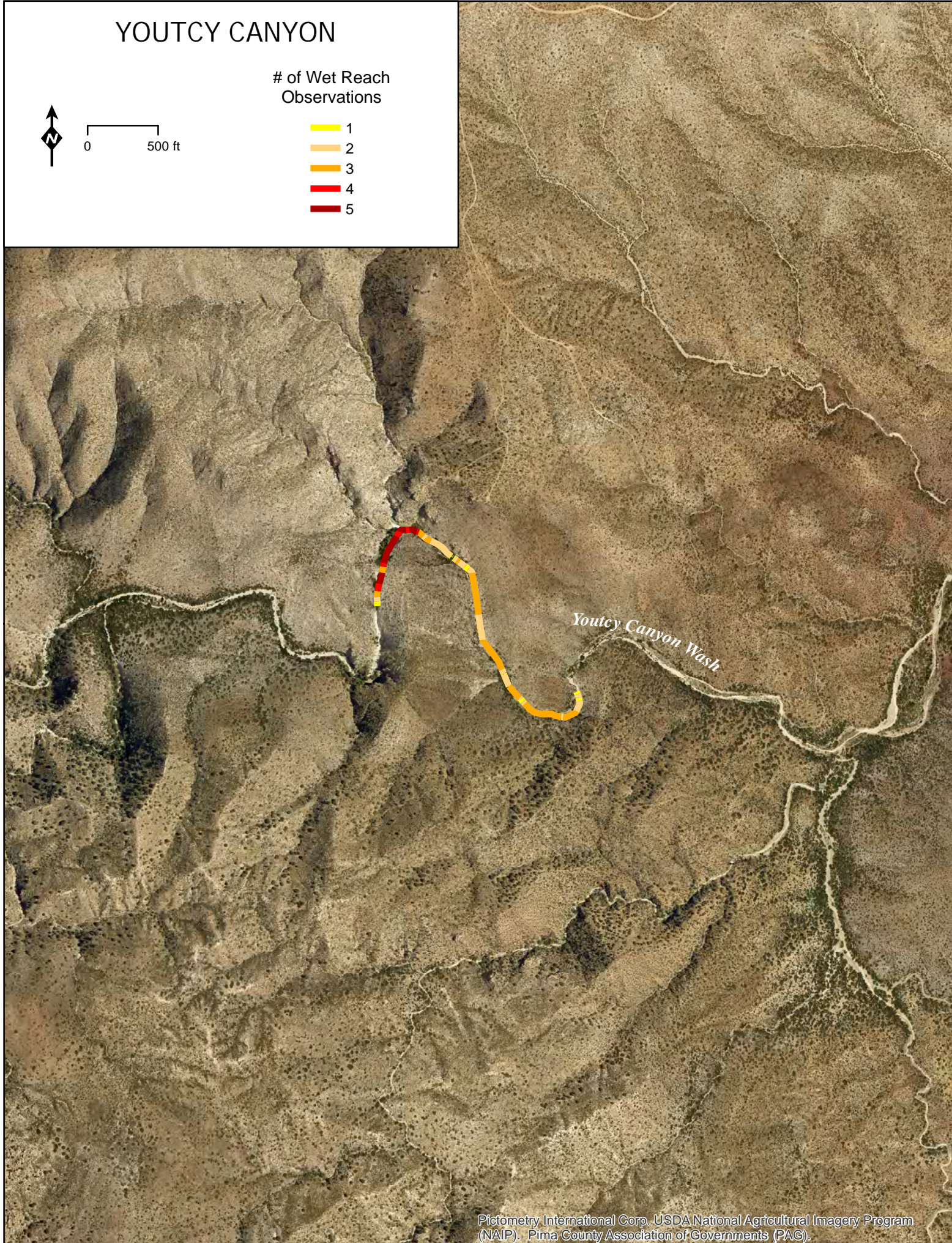
YOUTCY CANYON

of Wet Reach Observations



0 500 ft

- 1
- 2
- 3
- 4
- 5



**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 15

**RFCD Shallow Groundwater Area Monitoring Program
Water Level Data Collection Procedures**

Shallow Groundwater Area Monitoring Program

Water Level Data Collection Procedures

January 2019

Introduction

Groundwater level monitoring is conducted by the Pima County Regional Flood Control District (District) to evaluate the effects of climate and land use changes on local groundwater levels within various watersheds in Eastern Pima County. Monitored watersheds are characterized as those having significant natural resource values such as shallow groundwater (water levels above 50 feet below land surface), important riparian habitat, improved floodplain function and/or passive recreational interest. Water levels are measured in wells primarily owned by the District, but may also include privately owned wells and those managed by other public agencies. Data collection is by various methods including download from a local sensor (datalogger), manual sounding, accessing centralized databases and direct request to other parties.

Monitoring Locations

Groundwater levels are currently field measured by the District in five locations and one other watercourse is monitored using water level data supplied by the City of Tucson (Tucson Water) from their production wells. The five (5) areas field measured by District staff are:

- Santa Cruz River between Camino del Cerro and Avra Valley Road,
- Canada del Oro Wash in Catalina, Arizona,
- Santa Cruz River at Canoa Ranch,
- Cienega Creek and Davidson Canyon at the Cienega Creek Natural Preserve,
- San Pedro River near Bingham Cienega Natural Preserve (Redington, AZ).

Water level data supplied by the Tucson Water) is along Tanque Verde Creek from Wentworth Road to just downstream of Sabino Canyon Road. **Figures 1-6** display location maps for the wells along these watercourses.

Field Equipment

Field measurements of water level data include direct sounding of a well and downloading a datalogger if one is installed. The following equipment is needed for the site visits to perform these actions:

- Portable sounder or contact meter (w/ batteries)
- Laptop computer
- Direct Read USB cable reader
- USB docking station
- Tape measure or ruler

- Pipe wrench
- Master Lock Keys (2002, 0620 & A620)
- Field form(s)
- Cell Phone
- Calculator (cell phone has one)
- GPS Unit (to locate wells)
- Notebook with map site files
- Pen and/or pencil
- Datalogger operator's manual
- Large paper clip

The District currently has a Powers Well Sounder and a Stevens® Contact Meter for use in directly measuring water levels in wells. The Powers Well Sounder measures in units of feet, with numbers provided for every other foot (on the even numbers). A tape measure or ruler is needed to measure in between the one-foot marks. Note that the cable on the sounder has been broken and stretched – an error chart is located on the meter (one can also be provided) to determine the actual reading. The Stevens® Contact Meter measures in units of meters, so the reading will need to be divided by 3.28 to convert to feet. Make sure to have extra batteries on hand just in case the old ones run out of power.

Software for the dataloggers has been installed on two Toughbook laptop computers. CD ROM disks are available for download onto other computers if necessary or desired. All of the dataloggers have been deployed with a Direct Read cable. This allows the operator to directly connect the sensor to a computer, using the Direct Read USB cable reader, without having to remove the sensor from the well. However, there have been instances where a communication link could not be established (or maintained), thus the need for the USB docking station. The docking station requires the operator to remove the sensor from the well, as it will need to be disconnected from the cable and placed directly into the station.

A field form has been created to document the manual water level measurements taken during the site visits. A copy of the form is provided in **Attachment A**.

Manual Water Level Measurement

Manual measurements should be taken at each well, including those equipped with dataloggers. The monitoring well caps have been modified with a number of designs that may require a key to remove a locking cap and/or a pipe wrench to remove a threaded pipe cap. Once the cap is removed, a direct measurement can be taken by simply dropping the probe of the sounder or contact meter down into the well; note that the Powers Sounder needs to be turned on before use. The **sounder** will make a repetitive beeping sound once the probe reaches the water level - the power level display on the meter should be at the maximum before taking the reading. Use your hand to mark the point of first water contact and the ruler/tape measure to determine the inches. Calculate the final reading in feet using a calculator and the error chart. The

contact meter will only light up once the probe reaches the water. This meter has a graduated tape measure that can be directly read at the point of first water contact. The reading is in meters, so divide by 3.28 to convert it into feet.

Water Level Datalogger Download

The District has currently deployed In-Situ Rugged TROLL 200 and Rugged BaroTROLL dataloggers at selected sites shown in **Figures 1-6**. The Rugged Troll 200 dataloggers measure water levels with an accuracy of 0.1 percent and at ranges from 30 feet to 250 feet depending on the depth of deployment. Since the Rugged Troll 200 dataloggers are non-vented, no connection to the atmosphere, Rugged BaroTROLL dataloggers have been deployed to compensate for barometric pressure effects. A Rugged BaroTROLL can cover a network of Rugged Troll dataloggers within a 25-mile range.

Once the manual measurement has been obtained, the datalogger can be downloaded. Connect the Direct Read USB cable reader to the computer, turn the computer on and login to the system; note the user name and password are located on a note taped to the computer. Remove the cap from the Direct Read Cable and connect it to the reader. The sensor and cable do place a significant amount of weight on the connection, so you may want to use a large paper clip to hold it in place on top of the well monitoring port.¹

After logging into the computer, click on the “Win-Situ 5” icon. The program will ask if you want to connect to the device, so press “yes”. The program may let you know that the device (sensor) is not synchronized with the local system (computer). If the computer’s time has been updated, go ahead and press “yes”. If not, press “no”; the device time is usually pretty accurate with real time. Once connected, the program will display the time and the sensor’s temperature, pressure and depth. Click the “Logging” icon (note pad with pencil) and then click on the latest log listed to highlight it (should be the one that is currently running). Click the arrow pointing downward near the bottom middle of the screen and then select “new data”. Once the data has been downloaded (~12 seconds), you can view the information on the data screen by selecting “yes” or go back to the logging screen by selecting “no”. Downloaded data will automatically be saved in a file within the Win-Situ directory folder under the log name.

Please review the Operator’s Manual for the Rugged TROLL 100 and 200 and Rugged BaroTROLL Instruments for more details and step by step instructions (Pages 33-34).

¹ Many of the dataloggers are secured to the well caps using locking caps, which may need to be removed to access the data port. **A security chain should already be attached to each cable to insure that the sensor does not fall into the well should the connectors be accidentally disconnected.**

Once finished, you can then disconnect from the sensor by selecting “File” and “Disconnect” (or hit the connection button in the bottom right-hand corner) and then exit the system by selecting “File” and “Exit”.

After exiting the program, turn off the computer and disconnect the cable reader from both the sensor and computer. Put the cap back onto the Direct Read Cable and place the well cap securely back onto the monitoring port. **Be sure to lock the cap or well casing before leaving the site.**

Water Level Datalogger Setup

A new datalogger can be programmed in the office prior to the site visit or on-site. To program a new sensor or reprogram a used sensor, click on the “Logging” icon and then the “New” button (note with a star). The program will ask for the “Site Name”, which you can select from the dropdown list. If the sensor is for a new site, click the “Site” button (circle with a circling arrow), the “New” button, and enter the site name. The check mark button will save all changes. Next, select a name for the log using the current date (i.e., September 28 2018). Then click the right arrow button and select the measurement parameters, logging method, log interval, start/stop conditions, device memory and level reference – pressing the right arrow after each step. The measurement units are as follows: °F for temperature, mmHG for pressure and feet for depth. The logging method is Linear and the log interval is every 6 hours. The log start condition is set at the closest time to the regularly scheduled measurement intervals of 12:00 AM, 6:00 AM, 12:00 PM and 6:00 PM. Device memory is set to overlap data once the memory storage is full. The reference level is “Depth to Water”, with the number being the manual measurement collected using the sounder or contact meter. The final screen will summarize the log setup and, if all is correct, click the check mark button to save the information onto the sensor.

Please review the Operator’s Manual for the Rugged TROLL 100 and 200 and Rugged BaroTROLL Instruments for more details and step by step instructions (Pages 29-31).

New Water Level Data Log

A sensor that is already deployed may need to be reprogrammed due to changing conditions or to recalibrate the depth to water measurement. Reprogramming a sensor is the same as described in the previous section (Datalogger Setup). Prior to writing a new log, the old one will need to be downloaded and then stopped. If there is more than one log in the sensor memory, you will need to delete one of the logs before proceeding to create a new one; the sensor only allows two logs in the memory at one time.

Barometric Pressure Compensation

All of the water level dataloggers are equipped with non-vented, Direct Read cables. To correct for changes in atmospheric pressure, a barometric datalogger has been deployed in each watershed location. The barometric sensor will cover a range of 25 miles from its deployment. Barometric dataloggers are set up in much the same way as the water level dataloggers, however the device will not need a level reference. Some are equipped with Direct Read cable, but others will require the USB docking station to download.

Once the device is downloaded, data from all water level dataloggers in the vicinity can be adjusted using the BaroMerge software program. Click on the Win-Situ Baro Merge icon and select "Use a Baro TROLL file". Click the button to the right of this selection and then click onto the barometric sensor file. Click the right arrow twice and then select all of the sensors whose data you wish to correct within the range of the barometric datalogger. The check mark will correct all the data for each level sensor selected and save it in a separate file with a BaroMerge extension.

Centralized Database Review

The Arizona Department of Water Resources (ADWR) maintains a centralized database that displays information on all registered wells (and some unregistered wells) within Arizona, including water levels. This database can be accessed through ADWR's website via the Groundwater Site Inventory (GWSI). A Search Wizard will guide you through the process if you know the GWSI number or general location of the well. A Map can be used to locate all wells within a specific location in Arizona by zooming down to the area desired. Note that the Well Registry (Wells55) can also be used to locate wells with water level data, but you will need to click on the GWSI Site ID (if available) to access the data. Many of the wells have standard water levels that are directly inputted by ADWR staff, but there are some wells equipped with automated dataloggers that will measure water level data periodically and transmit it to the centralized database. Water levels can be reviewed and even downloaded onto a Microsoft Excel Spreadsheet. Note that automated water levels are highlighted in red on a separate tab within the database webpage. The ADWR websites for GWSI and Wells55 are as follows:

GWSI - <https://gisweb.azwater.gov/waterresourcedata/GWSI.aspx>

Wells55 - <https://gisweb.azwater.gov/waterresourcedata/WellRegistry.aspx>

Direct Request of Data

Tucson Water regularly measures water levels in a number of their production and monitoring wells, keeping a record that may or may not be submitted to ADWR. Many of the wells in the Tanque Verde Creek location are equipped with dataloggers that are downloaded by Tucson Water staff during the Spring months (April-June). Tucson

Water will provide this data upon request – currently performed via an email to the most recent contact:

Mr. Michael Liberti, GIS Project Manager
Michael.Liberti@tucsonaz.gov
(520) 837-2226

Pima County Natural Resources, Parks and Recreation measures water levels in the monitoring wells near Bingham Cienega Natural Preserve. This data is provided by Mr. Jess Barry on a quarterly basis (annually in July) through reports provided by the department within the County's network drive (V Drive) in the folder labelled Bingham Cienega – RFCD & NRPR. Direct data requests can be made to the current contact, Mr. Jess Barry: Jess.Barry@pima.gov or (520) 668-4980.

Data Review and Management

The District's Water Resources Division (WRD) oversees management of the Shallow Groundwater Area Monitoring program. Mr. David Scalero (Principal Hydrologist) is currently responsible for all program activities including:

- Data collection and management,
- Datalogger purchase and installation, and
- Field measurements.

Microsoft Excel spreadsheets have been developed for each field measured well to track both manual and automated readings. These spreadsheets are located in the District's network drive: Z:Shared Data_Division Files_WRD_Groundwater Monitoring Program_Water Level Data. The files are organized by watershed. Hardcopies of the field forms are currently kept in a personal file folder, but may be moved to a centralized file folder for the Water Resources Division in the future.

A separate spreadsheet has been developed to track both monthly (1st day of the month) and annual (closest measurement to January 1) data. This spreadsheet also includes other data such as stream flow and pumping that are used in the annual report to evaluate causes for water level rises or declines. The spreadsheet and associated data is also available in the District's network drive: Z:Shared Data_Division Files_WRD_Goundwater Monitoring Program.

Schedule

Data collection and reporting coincides with environmental updates by the District for the County's Sustainability Action Plan (SAPCO) and by the Office of Sustainability and Conservation (OSC) for the Multi-species Conservation Plan (MSCP) under the federal "Section 10" permit. Water levels are typically field collected at all sites in **January** and **June** of each year. City of Tucson staff are contacted in **June** to request data from their

wells in the Tanque Verde Creek shallow groundwater areas. ADWR's centralized database is periodically queried to obtain data from the wells they monitor.

Preparation of an annual report begins at the end of the County's fiscal year (**June 30**), with a delivery date for the final report at the end of the Calendar Year (**December 31**). A table of water levels and graphics displaying hydrographs for wells in the CCNP and Tanque Verde areas are prepared and delivered to Mr. Greg Saxe (District) for SAPCO reporting in **July**. Reports and data are also provided to other departments and agencies throughout the year upon request.

Figure 1. Lower Santa Cruz River Monitoring Wells

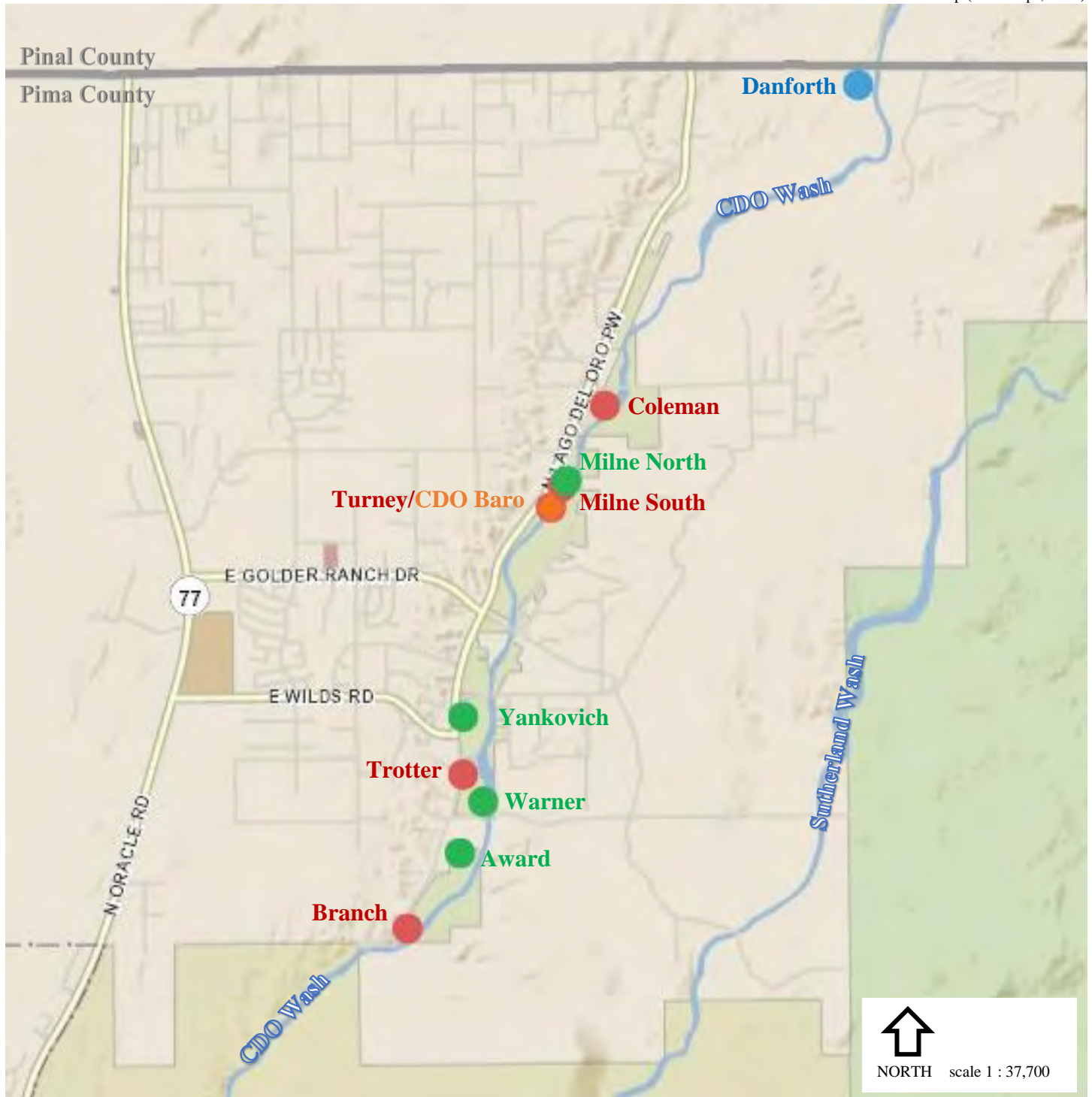
Street Base Map (PimaMaps 2018)



- SC Monitoring Wells (RWRD) - dataloggers in SC-06 & SC-07
- CTRDN Wells (RFCD) - manual readings
- MW Monitoring Wells (RFCD) w/dataloggers
- ◆ LSCR Baro (RFCD) - barometric pressure sensor

Figure 2. Canada Del Oro Wash (CDO) Monitoring Wells

Street Basemap (PimaMaps, 2018)



- Private Well - Manual readings
- Monitoring Wells (RFC) - manual readings
- Monitoring Wells (RFC) w/dataloggers
- ◆ LSCR Baro (RFC) - barometric pressure sensor

Figure 3. Canoa Ranch Monitoring Wells

Street Basemap (PimaMaps, 2018)



- Monitoring Wells (ADWR) w/ dataloggers
- Monitoring Wells (RFCD) - manual readings
- Monitoring Wells (RFCD) w/dataloggers
- ◆ Canoa Baro (RFCD) - barometric pressure sensor

Figure 4. Cienega Creek Natural Preserve Monitoring Wells

Street Basemap (PimaMaps, 2018)

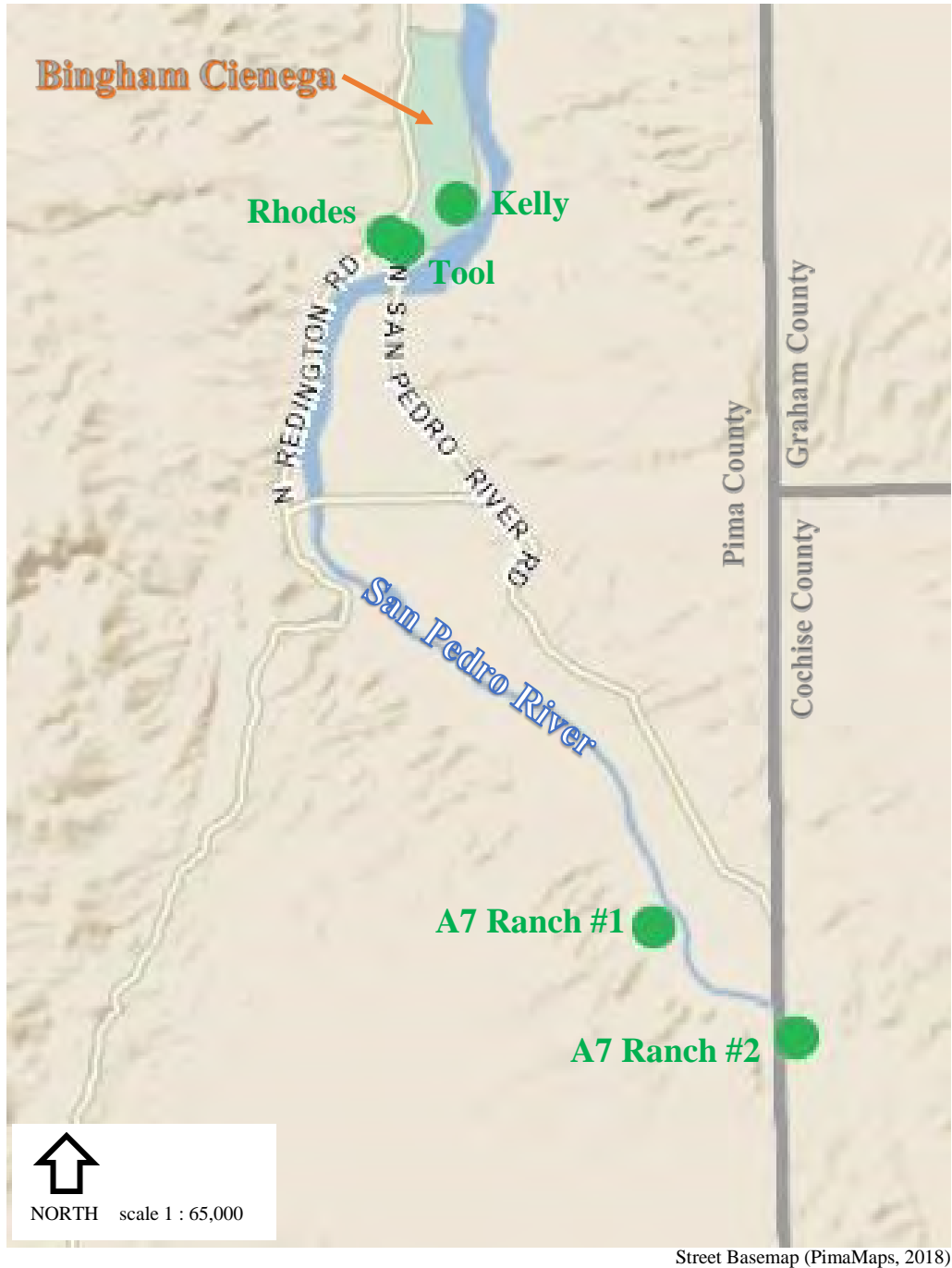


- Monitoring Wells (ADWR) w/dataloggers
- Monitoring Wells (RFCD) - manual readings
- Monitoring Wells (RFCD) w/dataloggers
- ◆ CCNP Baro (RFCD) - barometric pressure sensor



NORTH scale 1 : 140,000

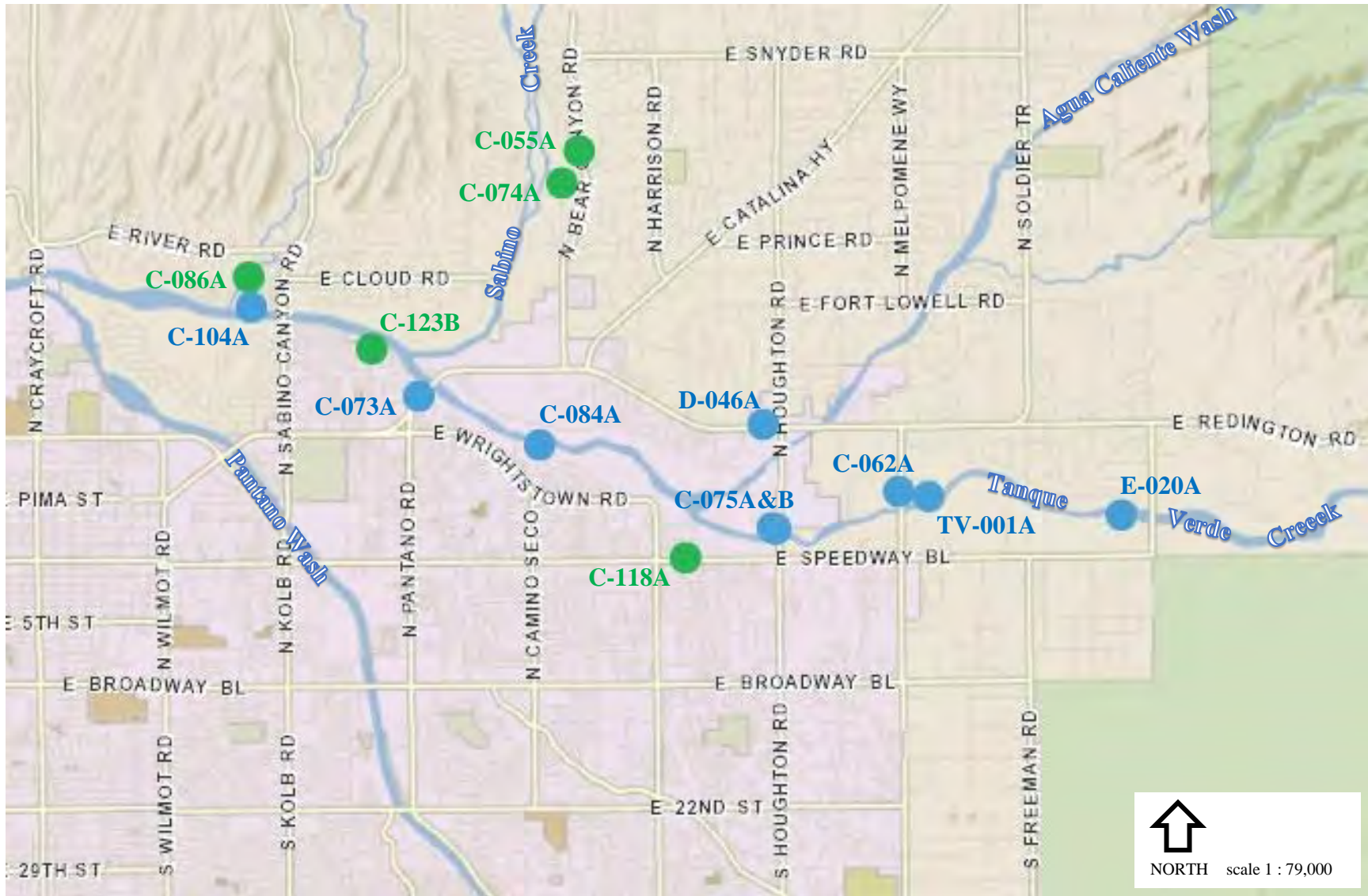
Figure 5. San Pedro River Monitoring Wells



- Monitoring Wells (NRPR & RFCD) - manual readings

***All wells are monitored by Pima County Natural Resources, Parks and Recreation. Data are available in their quarterly reports to RFCD (Network V Drive) or upon request.**

Figure 6. Tanque Verde Creek Monitoring Wells



- Monitoring Wells (COT) w/ dataloggers
- Monitoring Wells (COT) - manual readings

Street Basemap (PimaMaps, 2018)

Attachment A. Pima County Water Level Form – Wells

Date: _____ Watershed: _____

Sampler(s): _____

Well Registry #55- _____ Well Name: _____ Arrival/Departure Time: _____

Depth to Water _____ (meters) Powers Sounder _____ (feet) Adjusted DTW* _____ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: _____

Well Registry #55- _____ Well Name: _____ Arrival/Departure Time: _____

Depth to Water _____ (meters) Powers Sounder _____ (feet) Adjusted DTW* _____ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: _____

Well Registry #55- _____ Well Name: _____ Arrival/Departure Time: _____

Depth to Water _____ (meters) Powers Sounder _____ (feet) Adjusted DTW* _____ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: _____

Well Registry #55- _____ Well Name: _____ Arrival/Departure Time: _____

Depth to Water _____ (meters) Powers Sounder _____ (feet) Adjusted DTW* _____ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: _____

Well Registry #55- _____ Well Name: _____ Arrival/Departure Time: _____

Depth to Water _____ (meters) Powers Sounder _____ (feet) Adjusted DTW* _____ (feet)

Datalogger: Y / N ; Downloaded: Y / N Photos: Y / N ; Direction: N / S / E / W

Comments: _____

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 16

Raising the Arizona Eryngo Report

Raising the Arizona Eryngo

Report by Julia Fonseca, Pima County Office of Sustainability and Conservation for Jessie Byrd, Pima County Native Plant Nursery Manager.

August 2018

Abstract

The native Eryngo plant is a rare wetland plant that is currently being considered for listing under the Endangered Species Act. Twenty rare Eryngo plants from the Desert Botanic Garden were transplanted to Agua Caliente Park in 2017. Because no monitoring data had been previously collected, I conducted field visits in April and August 2018, interviewed staff, and reviewed photographs and plans to determine survivorship and examine factors that might influence successful transplants. Of the 20 original plants, only two plants survived to April 2018. By August 1, 2018, one of the remaining plants had died, and the other appeared to have reduced leaf mass. Damage to the young plants by javelina was an early cause of mortality, but placement of the plants in an inappropriate upland setting where they experienced water stress was the primary problem. In a separate propagation experiment, Pima County's Native Plant Nursery successfully grew around 130 additional plants from seed provided by Desert Botanic Garden. These new one-gallon plants could be placed either at Agua Caliente Park or Canoa Ranch. I recommend a second, small-scale trial at Agua Caliente in the area at the basin floor and perimeter of Pond 2's Native Planting Area. Assigning responsibilities for monitoring and reporting the condition of the transplants prior to the next transplant effort is also needed. A draft monitoring form is provided.

Purpose

The Arizona Eryngo, or *Eryngium sparganophyllum*, is a visually attractive, globally rare plant found on Pima County Conservation Land. The plant belongs to the Apiciaceae, or Parsley family, and produces striking white flowers rising above a perennial bush of strap-like leaves. The plant historically grew in wetlands associated with the Agua Caliente spring, but by the late 20th century the species had been extirpated from that site, leaving only two other known locations in the United States. One of those, near Tanque Verde Creek at La Cebadilla, occurs partially on land owned by Pima County Regional Flood Control District. The other known site is a spring-fed hillslope cienega in the San Pedro River valley.

In 2016, Pima County's Native Plant Nursery and the Pima County Regional Flood Control District (RFCDD) began investigating the potential to re-establishment the species at Agua Caliente Regional Park as part of a larger effort to revegetate areas of disturbance around a pond. This report provides an update on that initial effort at Agua Caliente and suggests additional sites and tools for help ensure successful reintroductions in the future.

Eryngo Source Material

Seeds for the initial trial were obtained by Jessie Byrd (Pima County Native Plant Nursery Manager) from Desert Botanical Garden (DBG) on January 25, 2016. The seed (DBG Accession #2016-0009-10-0; one packet) was originally collected by DBG in June and September 2014 from the District's La Cebadilla property. DBG Accession #2016-0009-10-0 consisted of one packet of seed. Accession 2016-0010-10

consisted of 21 plants for research and display. Figures 1 and 2 show the healthy condition of these plants as received by the Nursery.



Figure 1 DBG Eryngium received by Pima County



Figure 2 Close-up of plant when received from DBG

Pima County Propagation Experiment

The Pima County Native Plant Nursery is located at 5800 N. Camino de la Tierra, mailing address 3500 W. River Road.

Seeds were cold stratified by holding in a refrigerator for six weeks. The seeds were soaked and then placed into five flats. About three full flats of plants germinated, or approximately 130 seedlings.

The seedlings were transferred into 2 ¼ inch rose pots on July 20, 2017. The soil used was a 50:50 mixture of perlite and mulch. No fertilizer was used in the soil, and the water source for the rose pots is potable, therefore nutrient content of the water is low. The rose pots were located in the shade house.

Rates of growth appeared to increase after the plants were bumped into one-gallon pots on May 3, 2018 with a richer soil mix of 60% mulch and 40% perlite with Osmocote. The first flower stalk was observed to emerge from one of the plantings on July 10, 2018. The one-gallon plants continue to grow in the



Figure 3 The Pima County Nursery serves public projects.

shade house, with the intention that some of these will be planted at Agua Caliente Park. Plants will be taken from the shade house outside to acclimate them to outdoor conditions prior to transplanting. Ten of these plants were transferred in August to Boyce Thompson Arboretum for their collection (Jessie Byrd communication to the author, August 17, 2018).

2017 Agua Caliente Transplant Experiment

One-gallon flowering plants that were received from DBG were held several months at the Nursery before being transferred to Groundskeeper, a local contracting firm, for planting at the Park in September or October 2017. Groundskeeper substituted the *Eryngos* for eighteen monkeyflower and two pappus grass plants in the plans provided to them by Pima County Regional Flood Control District. This substitution was authorized by Sandy Bolduc, RFC, landscape architect for the Pond 2 rehabilitation effort at Agua Caliente Park.

I determined that soil conditions at the planting sites are a sandy loam (some silt and not much clay) using a field test of site soils. Some soils also have gravel. There is an abundance of either calcium carbonate or sodium sulfate in the soil, contributing to a whitish gray soil color. All plantings were in full sun. No fertilizer was used.

According to Amy Loughner, Agua Caliente Park manager, the contractor hand-watered all perimeter plants around Pond 2 and the Native Planting Area until the plants were installed onto the drip irrigation system (Figure 4). The drip irrigation system was operated manually three times a week for approximately 30 minutes each event. Plants on the perimeter of Pond 2 but outside the drip system were hand-watered one to three times a week by manually filling the wells around the plants.

Many of the *Eryngium* plants were uprooted by javelina right after planting, but it was not clear that the animals were eating the plants (Jessie Byrd, personal communication). Some surviving plants were caged in response (Jessie Byrd, personal communication). The two remaining plants looked healthy in April 2018, but had not grown noticeably since their planting. One surviving plant was located at the northern edge of Pond 2A, under a mesquite and near a saltbush. Another was in full sun on the southern edge of Pond 2B near a boulder. None of the *Eryngium* plants along the “improved land bridge” survived (Figure 4). These were irrigated with the manually-operated drip system.

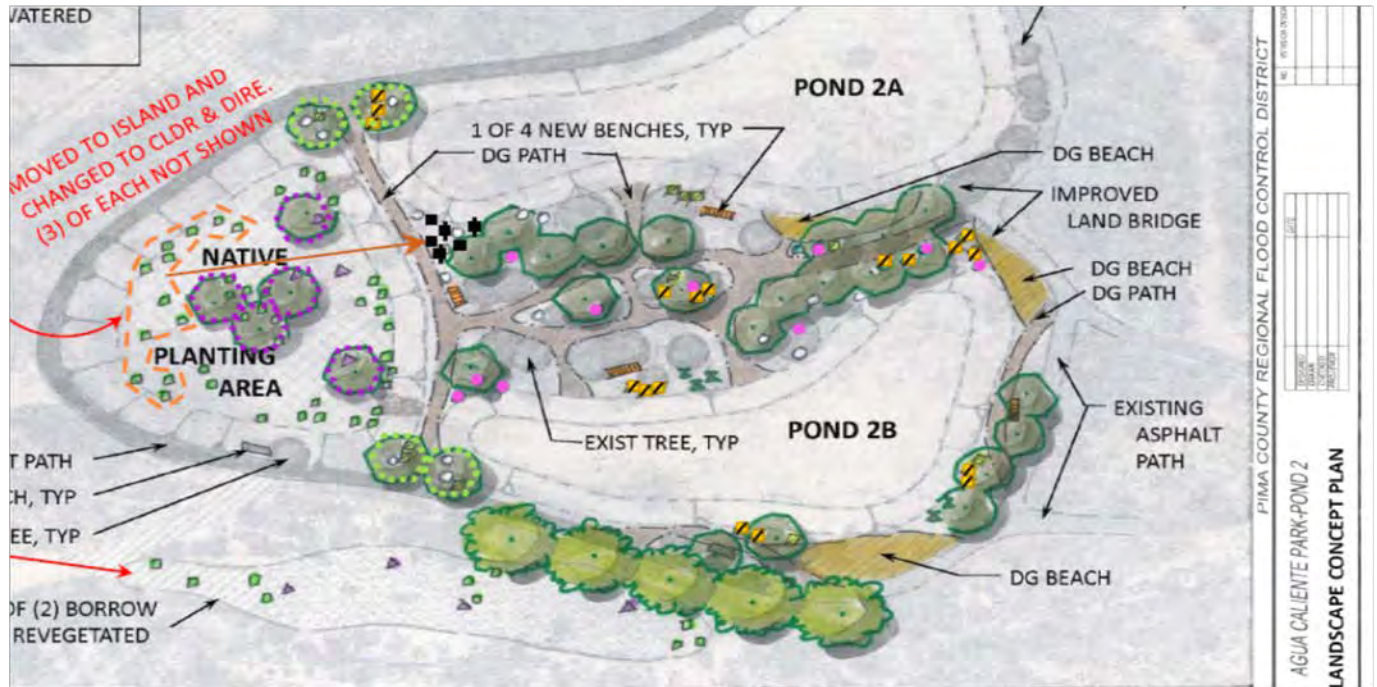


Figure 4 Partial view of as-built plan. Yellow circles and squares indicate *Eryngium* locations. Green squares indicate *yerba mansa*, which is another wetland plant. Many of the *yerba mansa* transplants successfully established as of August 2018.

Evaluation

Eryngium sparganophyllum was known to live in spring-fed wetland at what is today Agua Caliente Park (SWCA 2002). The plant is known from a specimen collected in 1908 by J. J. Thornber and Forrest Shreve. Forrest Shreve's specimen reported "marshy ground". My review of the specimen records collected concurrently with *Eryngium* are consistent with an herbaceous cienega: *Juncus bufonius*, *Salicaceae*, *Scirpus americanus*, *Almutaster pauciflorus*.

Evaluation of the 2017 transplant experiment at Agua Caliente was hampered by lack of any formal documentation of the plants during or after construction. I interviewed Jessie Byrd and Amy Loughner and reviewed emails and photographs and plans. I visited the site and discussed the issues with staff on April 11, 2018. I had additional communications with staff after the field visit, and visited again on August 1, 2018.

The key problem with the 2017 plantings appears to have been their location: the transplants were placed in upland locations on the uppermost perimeter of Pond 2, where they were unable to receive any natural runoff. The water table at Ponds 1, 2 and 3 is never near the root zone, so the available sites will depend on natural runoff or deliberate irrigation of some kind. *Eryngium* typically grow where the soil experiences seasonal saturation. Wetland plants were observed in the bottom of Pond 2A and the Native Planting Area during our site visit, but none of the *Eryngium* had been placed either in the bottom of the basin or along the lower basin slopes where the soils might be periodically saturated.

The placement of the Eryngos in upland settings where they depend on irrigation likely contributed to lack of survival. I visited all of the planting sites in August. Very few of the landscaping species that were placed in the uplands survived. Most of the sites were empty or had pappus grass (*Pappaphorum vaginatum*) or wheeler saltbush (*Atriplex wheeleri*). Pappus grass is the most drought tolerant species that was in the planting palette. No monkeyflower, virgin's bower, or *Dicliptera* survived, and very few of the other species survived. In some areas, the emitters were no longer visible. Because the surviving plants are those species that require little water, I believe water stress was a contributing factor to the demise of the container plants.

Competition with other plants was not an issue that led to the early demise of the DBG specimens, as each plant was initially placed alone in a planting hole surrounded by a small "well" of dirt intended to contain water to the well. As time passed, however, competition from adjacent upland plants increased for the two survivors at Pond 2. A wetland plant species such as Eryngo may not thrive in competition for water in an upland setting.



Figure 5 Typical upland planting sites near Pond 2A, August 1, 2018, with no *Eryngium* remaining.



Figure 6 At top left, the sole surviving *Eryngo* at Agua Caliente Park, outside Pond 2A, August 1, 2018. Arrow indicates plant location. Same plant below left, on April 11, 2018. Note flower and offsets. By August, leaf mass had been reduced and shrub and grass encroachment advanced. At top right, dead *Eryngo* leaves remain August 1, 2018. Below right, close-up view of the same plant on April 11, 2018. Note change in condition of well. Some burial may have occurred.

High soil salinities are present on the planting site, but are not thought to be limiting since the Arizona occurrences of the species I have seen are in settings where there is visual or chemical evidence of elevated salinity in the soil or spring water. For instance, I see visible accumulations of salts at the Flood Control District's La Cebadilla site where *Eryngos* have established on soils that were graded for development in the late 1970s (Figure 7). According to Wolkis and Stromberg (2016), the soils at La Cebadilla has the highest electrical conductivities of the six cienegas they examined. Agua Caliente spring water and soils have elevated levels of sodium and sulfate (Julia Fonseca, unpublished data), and alkali is present at Lewis Springs (Julia Fonseca, personal observation).

Low levels of organic soil matter and sandy soil texture at Pond 2 may be suboptimal for *Eryngium*. Perhaps this could



Figure 7 *Eryngium* at La Cebadilla, with alkali accumulation on moist soil, August 1, 2018.

contribute to water stress because sand and low organic content have low water-holding capability. At La Cebadilla, soils have approximately 20% organic matter, and 50% silt and clay (Wolkis and Stromberg 2016), and so water-holding capacity is higher.

Another factor contributing to the low success rate of transplanted individuals could have been poor placement of the young plants into the soil. It is possible that the landscaping contractor may have placed the crown of the plant too deeply. Evidence for this is my later observation of one plant which seems to have been placed too deeply for optimal growth. It could have been buried by the movement of soil after plant. I noted that many of the landscaping plants were placed on slopes where soils are moving downhill into the planting “well” but bioturbation by burrowing animals could also be a factor.

In conclusion, while javelina rooting is likely to have been the earliest observed cause of mortality, water stress due to placement of the plants in an upland setting is probably the primary cause of death. If this is true, successful establishment of the plant in wetland setting offered at Agua Caliente Park may still be possible if planting sites are chosen more carefully.

Prospects for Future Transplants at Agua Caliente Park

Pond 1

At present, Pima County and RFCD are considering establishing the species at Ponds 1 and 2 at Agua Caliente Park. I evaluated potential planting sites during my field visit of August 1, 2018. Suitable sites are those that will not experience trampling by visitors and which have fairly stable soils. This may prove difficult because there is substantial soil erosion and trampling around the west side of Pond 1. The steep eastern face of Pond 1 might be suitable if there were less competition from palm trees and more seepage from the pond. However, current plans for lining of Pond 1 will eliminate potential seepage on the eastern face. Thus, if the Arizona Eryngo is to have a place in the renovated Pond 1, it would need to be planned as part of the revegetation effort there.

Figure 8 shows an important vantage point for a view across the pond to the Rincons. Cattails and bulrush have been a constant maintenance issue here on the southern end of Pond 1. Maintaining viewpoints with shoreline vegetation that does not obscure views is an important objective for the design of Pond 1. Eryngos are an attractive bushy plants with tall flowers that bring in butterflies and other pollinators. They do not obscure views. Combined with other species such as yerba mansa, spikerushes and other species, it could complement the view, if the viewing area could be redesigned to minimize trampling of the shoreline.



Figure 8 Pond 1 Viewpoint, August 1, 2018.



Figure 9 *Eleocharis* on shore of Pond 1

Figure 9 is located near the Rose Cottage, where a wetland plant called *Eleocharis* grows along the shoreline. This plant indicates appropriate soil moisture conditions exist. If trampling is not too great, will the placement of the liner allow for this seepage to continue to create potential habitat? However, young and mature palm trees are located nearby. Shading and competition by palms may render the shoreline habitat unsuitable. Without control of the palms, will there be any shoreline sites around Pond 1 in the future?

Pond 2

Ponds 2A and 2B are lined with a high-density polyethylene membrane up to around two feet of the top. It is possible that *Eryngos* could be planted along the shoreline either above or below the liner, but if too low, the plants would be exposed to prolonged inundation and too high might induce water stress. Finding the right shoreline elevation could be difficult. The plants need periodic soil saturation, and their leaves need to remain above water most of the time. Pond 2 will eventually be used to hold the water from Pond 1 when the liner is installed later in 2019, so it would be important to know what water level might be maintained during that period. A long-term consideration is competition with other plants, but at this point, there is little shoreline vegetation of any kind.

Native Planting Area

In contrast to Pond 1, encroachment by palms is not evident in the Native Planting Area located west of Pond 2, and there is no trampling here. The Native Planting Area is an unlined basin that receives rainfall. A gate can be operated to allow inflows of water from Pond 2. Transplants of arrowweed (*Pluchea tessaria*) Goodding willow (*Salix gooddingii*) and yerba mansa (*Anemopsis californica*) have successfully established in the bottom of the Native Planting Area with far less expenditure of staff effort than the *Eryngo* plantings around Pond 2 required (refer to Figure 4 for details). Although the area was dry during April 2018, parts of the basin floor had some standing water in August 2018. The presence of the wetland indicator plants such as the yerba mansa, cattail and bulrush indicates that periodic saturation of the soil has occurred during past seasons. The location of yerba mansa is primarily along the western margin. This area should be tested with a small (10 plants?) trial of one-gallon potted *Eryngium* placed during the monsoon growing season, preferably in a year projected to have El Niño conditions (i.e., high winter precipitation). Additional sites exist elsewhere in the basin floor near the cattail-bulrush, and near the inlet on the northeastern margin of the basin.



Figure 10 *Yerba mansa* along the basin floor of the Native Planting Area has been successful. These root-perennial plants were barely visible in April, but runners were spreading rapidly by August 2018.

Other Locations

Suitable habitat may exist at a number of other Pima County facilities, such as the new pond at Canoa Ranch, Kino Ecosystem Restoration Project wetlands, Mesquite Circle Pond, or the Roger Road ponds. Occasional drying of ponds or other wetlands should not pose a threat to established plants.

A true cienega setting at a natural spring site would be ideal, such as at Peck Spring or Mescal Spring. Office of Sustainability will evaluate rural locations where the suitable conditions may exist for this species.

Additional Eryngo Transplanting Recommendations

1. Consider soil amendments such as addition of organic matter, especially if native soil at the transplant site is sandy or drains too quickly. If soil amendments are feasible, it is recommended to experiment— prior to transplanting new specimens—with additions and site soils in the greenhouse to determine optimal mixes.
2. Place transplants in a setting where periodic inundation by water is possible, rather than relying solely on drip or manual irrigation. However, avoid placing the plants where the entire plant would be submerged for days. Even wetland plants such as these need to have access to air and sunlight.
3. Identify who will be responsible for ensuring plants are properly placed into the restoration site, and ensure they pre-water the planting holes. While it is unclear that caging is necessary, it might be appropriate to cage a few plants to gauge the effects of herbivory.
4. Place transplants where soil movement is not likely to bury the basal rosette of leaves. The soil level in the container should be placed at the same depth as the surrounding soil, no higher or lower.
5. Record the actual placement of plants, similar to the as-built landscape plan for the 2017 Pond 2 effort, and provide this information to Julia Fonseca, Office of Sustainability and Conservation.
6. Avoid placing young Eryngos right next to bulrush, cattail or trees or shrubs. Avoid heavy shade, or areas that will be quickly shaded by young trees or palms.
7. Monitor each transplant experiment. Identify who will report the condition of the transplants and establish a reporting schedule. A draft monitoring form is attached (Table 1). Monitoring should include reporting on survivorship, sources of stress, and some index of growth. Repeated photographs can supplement the record. Results of monitoring should be sent to Jessie Byrd, Pima County Native Plant Nursery and Julia Fonseca, Office of Sustainability and Conservation.

Legal Status

Eryngium sparganophyllum is considered globally imperiled and has been petitioned for listing under the Endangered Species Act by the Center for Biological Diversity (2018). The species is not covered by the Section 10 permit held by Pima County and the Regional Flood Control District, nor is its salvage or harvest regulated by the Arizona Native Plant Law.

The petition sets in motion a process requiring U. S. Fish and Wildlife Service to issue an initial finding indicating whether listing may be warranted within 90 days after receiving the petition. We anticipate that USFWS will issue a call for available information after publishing the initial finding. Information about the ability of the plant to be propagated and transplanted to new or historic locations will likely be of conservation value to USFWS and others at that time.

Even if the species were eventually listed under the Endangered Species Act, plants would not be protected against take. If the plant is eventually listed, the Act would prohibit the removal and reduction to possession of an endangered plant from areas under Federal jurisdiction, or any activity that would damage or destroy such species on any other area in knowing violation of any state regulation, or in the course of any violation of state criminal trespass law.

References

Center for Biological Diversity 2018. Petition to the U. S. Fish and Wildlife Service to Protect the Arizona Eryngo (*Eryngium sparganophyllum*) Under the Endangered Species Act. Submitted April 2, 2018.

SWCA 2002. Wetland Plant Evaluations for Agua Caliente Park. Prepared for Pima County Sonoran Desert Conservation Plan by Priscilla Titus. <http://www.pima.gov/cmo/sdcp/reports/d8/023WET.PDF> accessed July 16, 2018.

Wolkis, D. and J. Stromberg, 2016. Plant Ecology of Sharp Springs Cienega and other Cienegas of the Santa Cruz Watershed. Arizona State Parks Interpretive Education Project. Arizona State University School of Life Sciences.

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 17

**Pima County Local Drought Impact Group (LDIG)
2018 Annual Report**

Draft

Pima County Local Drought Impact Group (LDIG)

2018 Annual Report

The Pima County Local Drought Impact Group (LDIG) has been an active component of County operations since 2006 when the Board of Supervisors adopted the Drought Response Plan and Water Wasting Ordinance (Chapter 8.70).

LDIG consists of water providers and local, state and federal agencies that have an interest in the cause and effect of drought conditions in Pima County. LDIG meets bimonthly to monitor the short-term and long-term drought status, discuss drought impacts and coordinate drought declarations and responses.

The County's Drought Response Plan and Water Wasting Ordinance established a four-stage trigger category that corresponds to the Arizona Drought Monitor Report and their declaration of a watershed drought condition from "Abnormally Dry" to "Exceptional." Each "Stage" declaration within the county triggers drought stage reduction measures.

LDIG explores the impacts of drought on various sectors in Pima County including agricultural water use, ranching, wildfire, hydrology, and flooding. Because many water providers depend on Central Arizona Project water, LDIG also monitors the status of the Colorado River, the El Niño Southern Oscillation (ENSO) and other climate weather patterns in relation to their effect on drought conditions and climate variability in the southwest. LDIG also monitors the status of the summer monsoon season and convenes roundtable discussions of drought and water conservation outreach programs. For a list of presentations and agendas, please visit Pima County's LDIG website.

This report is provided for inclusion in the Arizona Drought Preparedness Annual Report and submitted to the Pima County Administrator's Office.

Weather (National Weather Service-Tucson)

In Pima County, the 2018 Water Year began following a warm and dry period from mid-August through September that would lead into a record warm, dry fall season. October 2017 was warm with temperature extremes and a few scattered showers but no officially recorded rainfall. November was dry and the warmest on record as high pressure systems brought excessive heat. Fall 2017 was the hottest and driest on record. Record heat and dryness would continue through January 2018.

February lurched from average high temperatures of 10.9° above normal and no rain to average highs 6.6° below normal and localized rainfall ranging 2-6" due to Pacific systems moving in sub-tropical moisture. Despite the late month cooling, Winter 2017-2018 ended as the warmest on record. A dry Pacific system lowered temperatures in March but heat returned in April along with record dryness. With similar conditions in May, Spring 2018 ended as the driest on record and 4th warmest.

In mid-June, leftover hurricane moisture ended a dry streak of over 100 days with 0.71" above normal rainfall for the month. Monsoon activity brought normal rainfall with localized amounts as high as 5". August weather delivered the first above normal rainfall for that month in over a decade. Overall, Summer 2018 had an inch above normal rain and was ranked as the 7th warmest.

September high pressure brought a near record streak of triple digit temperatures as well as reduced thunderstorm activity until moisture from Hurricane Rosa poured into the state though in Tucson the month ended with below normal precipitation. Overall, the Water Year total precipitation was 9.59" with the normal being 11.59" or 2.00" below normal and the year to date total was 9.00" with the normal being 9.20".

Precipitation (in inches, recorded at Tucson Intl Airport)

WY17-18	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precip.	0.00	0.09	0.50	0.02	1.96	0.00	0.00	0.00	0.91	2.26	2.71	1.14
PrecipNorm	0.89	0.57	0.93	0.94	0.86	0.73	0.31	0.23	0.20	2.25	2.39	1.29
D+/-	-0.89	-0.48	-0.43	-0.92	1.10	-0.73	-0.31	-0.23	0.71	0.01	0.32	-0.15
C	-0.89	-1.37	-1.80	-2.72	-1.62	-2.35	-2.66	-2.89	-2.18	-2.17	-1.85	-2.00
Rank	1st Dry	34th Dry	54th Dry	14th Dry	10th Wet	1st Dry	1st Dry	1st Dry	11th Wet	51st Wet	35th Wet	58th Wet

Average Temperature (in °F, recorded at Tucson Intl Airport)

WY17-18	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
AvgTemp	77.3	69.1	57.3	59.1	57.5	63.0	72.6	78.5	86.8	89.0	86.5	84.9
TempNorm	71.0	59.8	51.9	52.6	55.3	60.1	67.0	76.0	84.8	87.0	85.3	81.6
D+/-	6.3	9.3	5.4	6.5	2.2	2.9	5.6	2.5	2.0	2.0	1.2	3.3
Rank	2nd Hot	1st Hot	2nd Hot	1st Hot	19th Hot	15th Hot	2nd Hot	11th Hot	14th Hot	8th Hot	15th Hot	1st Hot

2017-2018 Season Ranking (NWS-Tucson)

WY17-18	Fall	Winter	Spring	Summer	Monsoon
Precp Rank	1st Dry	49th Wet	1st Dry	31st Wet	37th Wet
Temp Rank	1st Hot	1st Hot	4th Hot	7th Hot	8th Hot

Pima County Drought Conditions

WY 17-18	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Short Term	D1(57) D0(43)	D1(90) D2(10)	D1(90) D2(10)	D1(90) D2(10)	D2(73) D3(27)	D2(73) D3(27)	D2(73) D3(27)	D2(70) D3(30)	D3(80) D2(20)	D3(80) D2(20)	D2(80) D1(20)	D2(80) D1(20)
Long Term	D2, D3	D2, D3	D2, D3	D3, D4	D3, D4	D3, D4	D3, D4	D3, D4	D3, D4	D3, D4		

D0-Abnormally Dry, D1-Moderate, D2-Severe, D3-Extreme, D4-Exceptional. (percentage)

Pima County Drought (US Drought Monitor & Monitoring Technical Committee)

Short Term

The 2018 Water Year started with a mix of Moderate drought in western Pima County and an eastern pocket of Abnormally Dry. Through November, Moderate drought expanded across all of Pima County as Severe drought began in the southwest corner. By late January, there was rapid development of Severe drought covering the County with Extreme drought in the southwest corner. In May, Extreme drought expanded from the northwest all across Pima County leaving only a small area of Severe drought in the eastern portion. By August, Extreme drought had receded to the west leaving Moderate and Severe drought in the east. Improvement continued through August and remained steady through September as the County recovered from Extreme drought leaving Severe drought and a small eastern portion of Moderate drought.

Long Term

From October to December, western Pima County was in Extreme and Severe drought radiating to the east with only small portions of Moderate drought in the northeast and southeast corners. By January, Exceptional drought had developed in the western areas. Drought condition continued unchanged through June.

Colorado River Basin & Central Arizona Project (CAP)

Pima County CAP Water (acre feet annually)

CAP Agriculture Pool	
Cortaro Marana Irrigation Dist.	4,313
Farmers Investment Co.	2,323
Kai-Avra Farm	1,575
BKW Farms	1,226
Kai-Red Rock Farm	750
<i>Total</i>	10,187
CAP NIA Water	
Freeport	5,678
Rosemont Copper	1,124
Town of Marana	515
<i>Total</i>	7,317
CAP Tribal Allocations	
Tohono O'odham	74,000
Pascua Yaqui	500
<i>Total</i>	74,500
CAP M&I Contracts	
City of Tucson	144,191
Metro DWID	13,460
Town of Oro Valley	10,305
Spanish Trail Water Co.	3,037
Community Water Co-Green Valley	2,858
Flowing Wells Irrigation Dist.	2,854
Town of Marana	2,336
Green Valley DWID	1,900
Vail Water Co.	1,857
<i>Total</i>	182,798

Pima County water providers and users are taking delivery of water from the Central Arizona Project. Tucson Water has the largest CAP annual municipal allocation in the state. Metropolitan Domestic Water Improvement District (DWID), the Town of Oro Valley and others have smaller CAP allocations. Agricultural users and the Tohono O'odham Nation also have access to and use CAP water. Consequently, the drought status of the Colorado River and the potential for a shortage declaration is of interest to these sectors.

Pima County CAP Municipal and Industrial (M&I) contracts total 182,798 acre feet a year or 29% of all CAP M&I contracts. With tribal allocations, Non-Indian Agriculture (NIA) water and the Agriculture Pool, Pima County could take delivery of 279,802 acre feet a year of CAP water.

Drought Contingency Plan

Arizona Department of Water Resources (ADWR) and Central Arizona Water Conservation District (CAWCD) committed to a joint stakeholder process to discuss and recommend how to adopt and implement the Lower Basin Drought Contingency Plan (LBDCP or DCP). LBDCP would overlay the 2007 Interim Guidelines for Lakes Mead and Powell operation during Lower Basin shortage. By taking additional cuts to Colorado River deliveries ahead of the existing tiered shortage plan, the Bureau of Reclamation and Lower Basin states hope to avoid a rapid decline in Mead's supply. These earlier and deeper reductions have been modeled to slow or arrest decline below 1,025' but not prevent a Tier 1 shortage.

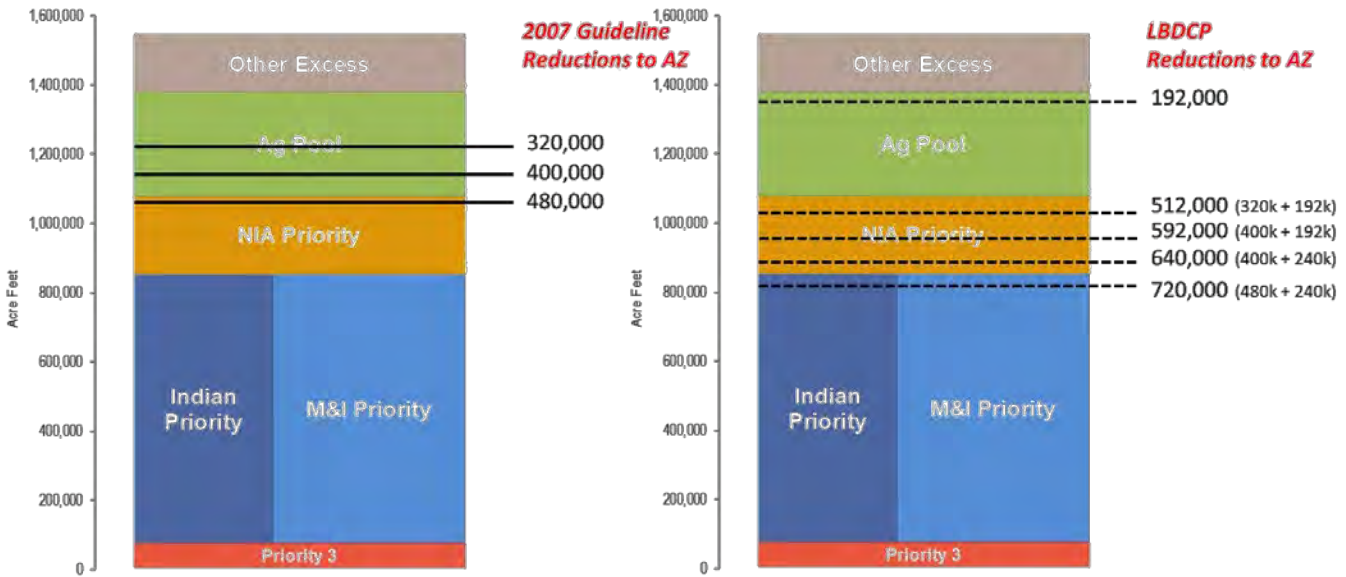
ADWR and CAWCD hosted two public briefings and assembled a LBDCP Steering Committee to reach consensus on the issues needing resolution for successful implementation of the LBDCP. The 38-member committee includes Pima County delegates representing various sectors and will meet through November with the goal of obtaining a joint resolution from the Arizona Legislature that will authorize the implementation of the LBDCP.

The priority issues for the committee are:

- CAP Agriculture Mitigation- Under the LBDCP, the Agricultural Pool supply is eliminated in a Tier 1 shortage. This sector bears most of the burden with limited benefit.
- Tribal ICS- Intentionally Created Surplus (ICS) is a supply management tool that allows for more water to stay in Lake Mead. Giving tribes the ability to create ICS will add to management flexibility.
- CAP Excess Water Plan- This supply has been a major contributor to the conservation water already in Lake Mead and is responsible for keeping the Lower Basin out of shortage. Collaboration is needed to continue realizing the multiple benefits of this supply.
- Arizona Conservation Plan- An intra-state plan must have broader participation in spreading LBDCP reductions across priority pools to gain sufficient support.

LBDCP Steering Committee – Pima County Regional Delegates	
Timothy Thomure	Tucson Water
Joseph Olsen	Metropolitan DWID
Brian Wong	Pima County Agriculture/SAWUA
David Godlewski	SAHBA
Ted Maxwell	SALC
Chairman Edward Manuel	Tohono O'odham Nation
Rep. Rosanna Gabaldon	Legislative District #2
Sen. Lisa Otondo	Legislative District #4

2007 Existing Tier 1-3 Shortages vs LBDCP Additional Tier Shortages



Lake Powell and Lake Mead

Inflow into Lake Powell was well below average with observed Water Year inflow at just 43%. With less than half of normal inflow and Water Year 2019 forecasted to be below average, elevation at Lake Powell will likely decline unless a significant event delivers improved inflow. The forecasted elevation at Lake Mead going into 2020 is 1,070', which would trigger a shortage for that year. The probability of shortage in 2020 does not take into account a DCP or additional conservation. Analysts believe modeling at this time indicates that if inflows into Lake Powell for 2019 are greater than 75% of normal, a reduced release of 7.48 MAF would be avoided; any less than 75% of normal would trigger a shortage even if a Drought Contingency Plan were in place.

Lake Powell Unregulated Inflow	Million acre feet	Percent normal
April-July 2018	2.602	36%
August 2018	0.011	2%
September 2018	0.001	<1%
WY2018	4.612	43%

Lake Powell Unregulated Inflow	Million acre feet	Percent normal
WY2019 Forecast- Most Prob.	8.1	75%
_Min Probable	4.8	44%
_Max Probable	15.6	144%

Elevation Forecast	Lake Powell	Lake Mead	Powell Release
WY2019_Most Prob.	3,581' (43%)	1,070' (35%)	9.00 Million acre feet
_Min Probable	3,566' (36%)	1,057' (32%)	8.23 Million acre feet
_Max Probable	3,648' (70%)	1,079' (38%)	9.00 Million acre feet

Impact in Pima County

Wildfire

Southern Arizona's fire season activity decreased in 2018 in comparison to previous years. Wildfire burned over 75,000 acres in 2017, the Sawmill and Burro fires accounting for most of that total. In 2018 the total acreage was a tenth of that just over 7,500 acres.

Agriculture and Ranching

Agriculture in Pima County is largely irrigated and there are six permitted groundwater savings facilities using CAP water. There were no agricultural drought impacts reported.

Energy

In August, the western energy market was disrupted by heat and wildfire in California causing supply problems as less energy was available to western states. Power companies were not able to prepare for the pricing and availability problems. For several days power companies in southern Arizona asked customers to do everything possible to conserve energy in order to prevent a brownout.

Kino Environmental Restoration Project (KERP)

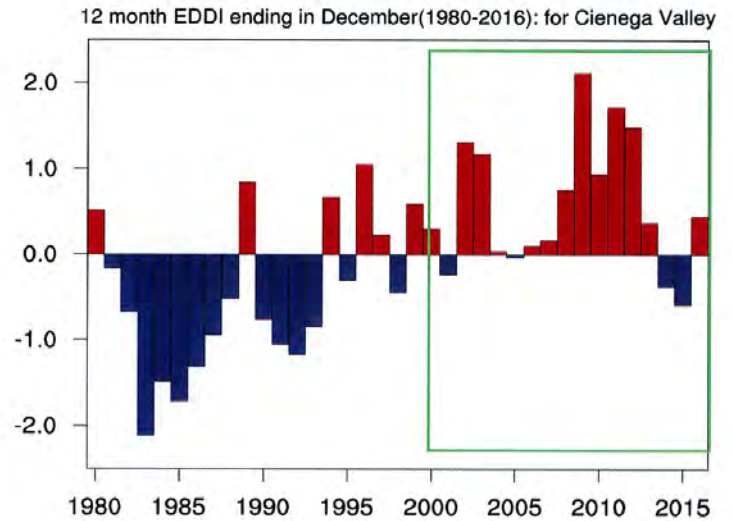
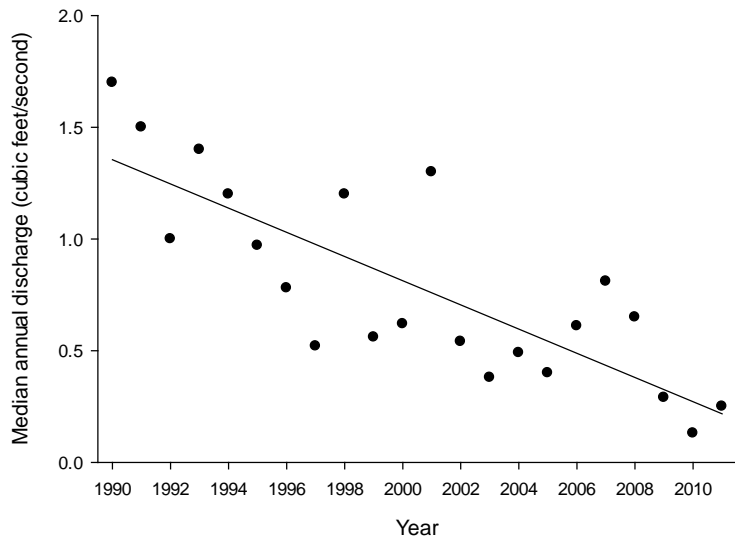
KERP is an environmental restoration project that harvests urban storm water and controls flooding in Tucson. KERP covers 141 acres with 28 acres of open water and riparian habitat. A central pond banks storm water and stores the water for irrigation within the KERP basin and Kino Park. The six acre "Deep Pond" is 50' deep when full. This year, KERP had no inflow from mid-August through January and the pond receded to two acres, a record dry period that has not occurred since the project was completed in 2002.

Cienega Creek

Cienega Creek, in eastern Pima County, continues to show the impacts of sustained drought. Pima Association of Governments' (PAG) drought reporting uniquely depicts the localized drought impacts on a shallow groundwater dependent system, important for habitat and rural residents dependent on this water source. With long term support and interest from its member jurisdictions, PAG has consistently monitored the shallow groundwater-dependent riparian area of Cienega Creek Preserve on a monthly and quarterly basis since 1989 and reported the findings to ADWR for compilation into state records.

In the monitoring year 2017-2018, PAG observed a decrease in Cienega Creek and Davidson Canyon's perennial flow extent. Both are Arizona Outstanding Waters. Monitoring during the driest time of year (May/June) maps the segments that contain perennial (year-round) surface water. PAG's long-term consistent inventory of Cienega's hydrologic conditions shows a long-term downward trend. To illustrate, in June 2018, Cienega Creek flows were present in less than 15% of the 9.5-mile monitoring area, which had flowed perennially in 1985. Since 2010, during the wettest season of the year, Cienega Creek's base flow has only reached up to 4 miles of flow. In Davidson Canyon, 2010 to 2016 were peak drought years in which the perennial segment occasionally stopped flowing during the driest part of the year, with flowing extent ranging from 0.00 to 0.033 miles in June. In June 2017, there was recovery with 0.124 miles of flow but a drop to 0.077 miles in 2018.

The graphs below illustrate the history of decline in annual discharge from Cienega Creek and drought condition. Medium annual discharge was measured at the Pantano gage. The Evaporative Demand Drought Index (EDDI) shows drought conditions (in red) and increased occurrence since 2000 (green box). Higher positive values on the Y axis indicate more extreme drought.



Agua Caliente Park

Agua Caliente Park, located northeast of Tucson, has historic and cultural significance. The park's focal point is a natural artesian spring that feeds a creek and produces an abundant variety of oasis vegetation and a habitat for native species. The natural spring originally flowed naturally into two constructed ponds dating to the late 1800s, but in recent years, the spring has stopped flowing. Water is currently being pumped to feed the first pond to maintain the wetland habitat, which also produces a recreational element for neighborhood residents and park visitors. Well pumping, however, only sustains one pond after failure of the spring.

Over the last few years, the well discharge was increased to maintain the main pond at Agua Caliente Park. In order to reduce water loss at a second pond, it was divided into two separate lined ponds. A natural unlined area was retained for seasonal wildlife habitat. The well discharge has maintained the main pond and one lined pond. A proposed plan to renovate and seal the main pond at Agua Caliente Park will help reduce groundwater pumping.

Sabino Canyon

Sabino Canyon is a popular destination and tourist attraction in the Coronado National Forest northeast of Tucson with numerous hiking trails along Sabino Creek. Due to the dry fall and winter, Sabino Creek had no stream flow for 153 days, beginning in mid-September and finally recording measured flow from February's precipitation.

Drought Response Actions

Pima County Regional Wastewater Reclamation Department (RWRD) produces highly treated reclaimed water that is reused in three ways; direct reuse in the reclaimed system, aquifer replenishment through recharge or for environmental projects. A significant portion of reclaimed water is released into the Lower Santa Cruz River. Storm water runoff provided over 15,000 acre feet of water to the river during Water Year, whereas discharge of effluent provided around 40,000 acre feet. Daily discharges of reclaimed water have maintained persistent flows along the channel downstream of the two County water treatment facilities despite the regional drought. Discharges to the river decreased by an average of 11% from a 2013 baseline.

Pima County continues to support Conserve to Enhance (C2E), which urges water conservation that translates into donations to support environmental enhancement. C2E participants have saved 10 million gallons of water since the program inception in 2011, through conservation strategies ranging from behavioral changes to rainwater harvesting installations. C2E has awarded funding to local neighborhood projects totaling approximately \$100,000 in investment. Pima County employees can now donate to C2E through the County's Employees Combined Appeal Program (ECAP).

The Conservation Effluent Pool (CEP) is an effluent allocation set aside pursuant to intergovernmental agreements between the City of Tucson and Pima County for use in riparian restoration projects. No recent formal requests for CEP projects have been submitted. In 2017, the Gila topminnow was detected in the Santa Cruz River and confirmed by subsequent surveys in the effluent stream. CEP water may be useful in maintaining a minimal flow that would safeguard this endangered species.

Pima County continues to adhere to its policy framework regarding water resources and drought management. This framework includes goals and recommendations from planning documents and annual reports cataloging progress and resources. These documents are posted on the County's Drought Management webpage:

- Water & Wastewater Infrastructure, Supply and Planning Study, Action Plan and Annual Report Cards.
- Water Resources Asset Management Plan
- Strategic Plan for Use of Reclaimed Water
- Sustainable Action Plan for County Operations
- Drought Response Plan and Water Wasting Ordinance

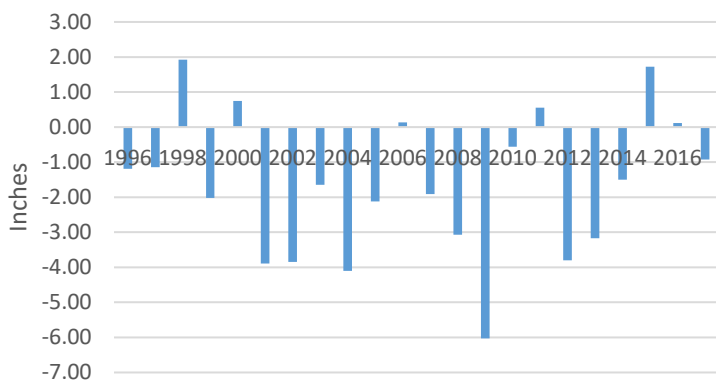
The County is currently updating its Strategic Plan for Use of Reclaimed Water to account for population growth and infrastructure development resulting in changes to effluent volumes in different regions of Pima County. The updated Plan will project future effluent supply and demand and recommend actions to maximize effluent use at both metropolitan and regional water reclamation facilities.

An Underground Storage Facility (USF) application for the Green Valley Water Reclamation Facility was withdrawn to be resubmitted pending data collection for hydrologic modeling.

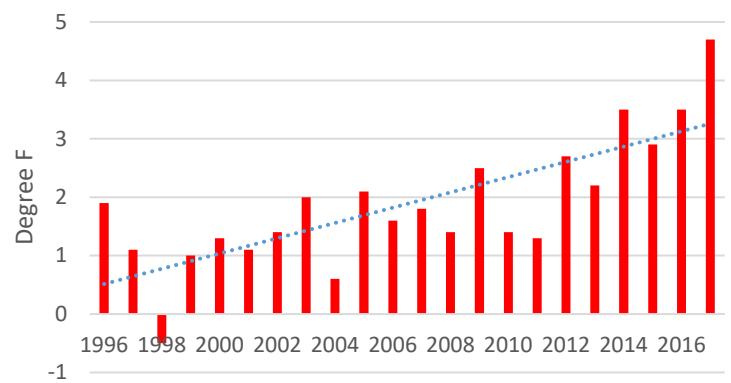
Pima County Resolutions 2017-39 and 2017-51 reaffirm the County's commitment to address climate change and align County operational efforts and Sustainable Action Plan with the Paris Agreement to reach carbon emissions reduction targets. As part of this effort, the County plans to install green infrastructure on County property and rights of way. The Green Infrastructure and Low Impact Development with Trees (GI-LID+Trees) report was drafted by an inter-departmental working group to identify and recommend appropriate sites for GI and tree installations. The report analyzes return on investment from the financial, social and environmental benefits. Pilot projects have been approved and the project has been expanded.

In order to ensure the County is prepared for water resource impacts resulting from climate change, staff reviewed drought management strategy in relation to current and expected climate change risks to various sectors, producing a Drought and Climate Change report. In the past twenty years, Pima County has experienced a 14 percent decline in precipitation, a deficit of 34.81” of rain. During the same time, annual average temperatures have been increasing, part of the long term trend evident for decades. The four-year period of 2014-2017 ranks as the warmest on record. As a connection is extrapolated between the probability of increased drought and severity of impacts and higher temperature, County drought management strategy will be informed by accepted climate and drought research and adaptation and mitigation strategies.

Precipitation Departure-Pima County



Temperature Departure-Pima County



The Lower Santa Cruz River Management Plan (LSCRMP) is purposed to develop a management strategy to balance flood risk management, drainage infrastructure protection, water recharge, recreation opportunities and riparian habitat preservation for the Santa Cruz River from Grant Road to Trico Road. This multi-benefit project will maximize recharge of effluent within the channel. Stakeholder comments have been received and responsible parties are collaborating on a task list.

Pima County is acting as co-manager with the Bureau of Reclamation in a three-year study of the Lower Santa Cruz River Basin (LSCRB). The in-kind study offers Bureau technical expertise in applying climate change models to water supply and demand scenarios, charting the potential range of water imbalance in the region and developing adaptive management strategies to mitigate imbalance and climate change.

As of now, the region’s water providers and other entities with established drought plans are at Drought Stage 1 or its equivalent (voluntary reductions).

Summary

Pima County had a record warm fall and winter along with a record dry spring. Monsoon activity was not sufficient to overcome a water year precipitation deficit. Severe drought persisted from February through September. While the fire season in Pima County was minimal, creeks and springs are continual impacted by each year of drought.

Pima County has effective water resource and drought management plans established with new management plans and studies underway to maximize efficient use of available water resources. The County will continue to monitor local, state and regional drought conditions, assess direct and indirect impacts and analyze cascading effects.

**Pima County
Multi-species Conservation Plan:
2017 Annual Report**

Appendix 18

**MSCP potential mitigation land acquisitions and
releases during 2018**

Potential Mitigation Land Acquisitions:

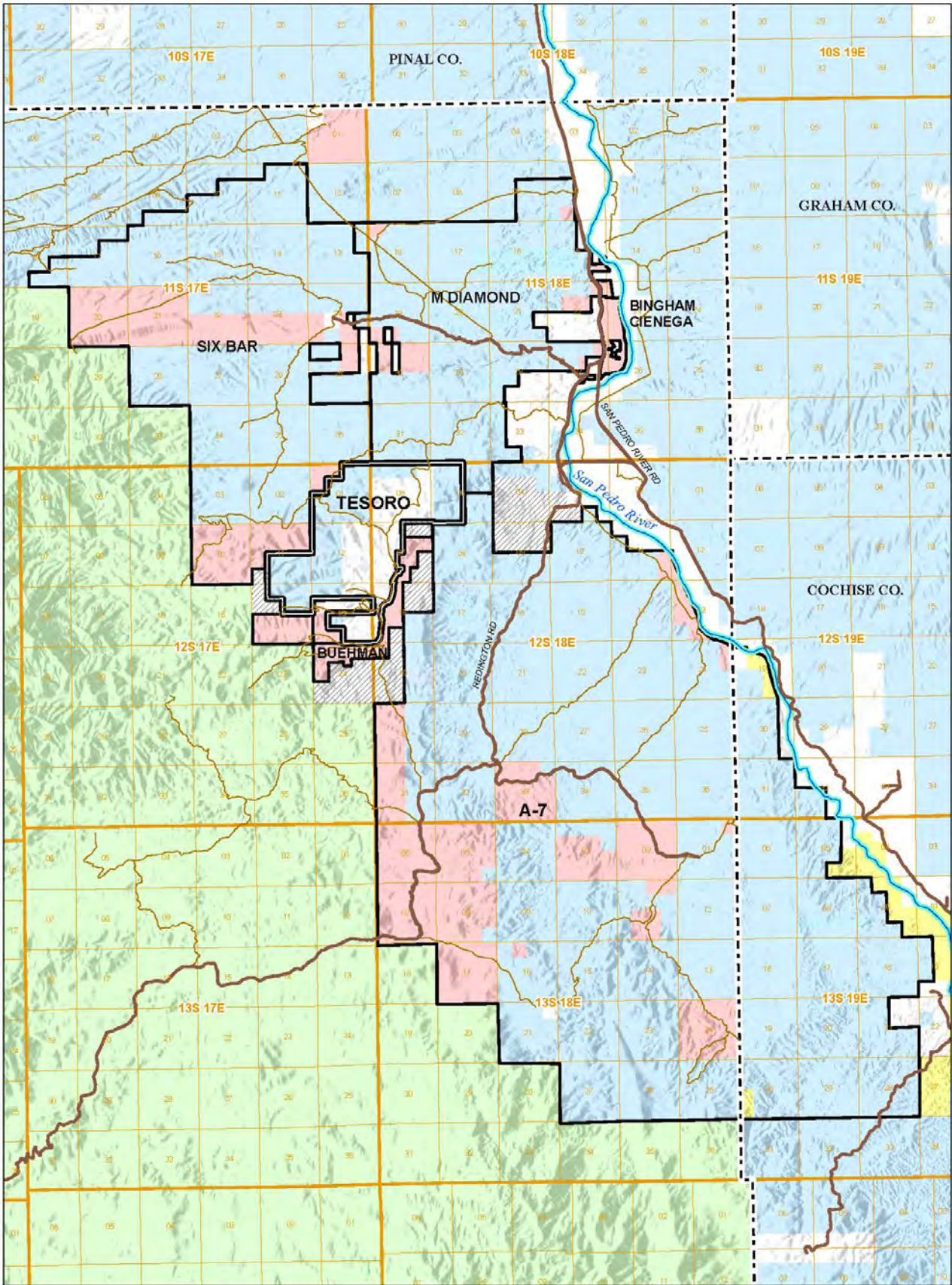
On June 19, 2018, the Pima County Board of Supervisors voted to acquire the Tesoro Nueve Ranch. This property is located on the east side of the Santa Catalina Mountains in the San Pedro River watershed, and is surrounded by County and Regional Flood Control District conservation properties as well as Coronado National Forest lands and The Nature Conservancy conservation easements. This property contains the best remaining perennial spring in the Buehman Canyon drainage, and represents the last portion of the drainage that was not yet conserved. The acquisition totals 3,282 acres (1,476 acres of fee land and 1,807 acres of state grazing leases).



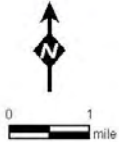
Figure 1. Buehman Canyon runs through the eastern portion of the Tesoro Nueve Ranch. Buehman Canyon is an important riparian and aquatic stream resource in the San Pedro River watershed and is home to rare and important species in our region.



Figure 2. A key feature of the Tesoro Nueve Ranch is Carpenter Spring, which gushes from the hillside just above Buehman Canyon and feeds a large wetland system that is home to longfin dace (a small minnow-sized fish) and one of the largest populations of lowland leopard frogs in the Santa Catalina Mountains.



TESORO NUEVE RANCH & ENVIRONS



- Pima County
- Coronado National Forest
- Private
- TNC Conservation Easement
- State Trust
- BLM



11/30/2017

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Potential Mitigation Land Removals:

In May 2018, 1.15 acres was released from the MSCP Restrictive Covenant subsequent to necessary approvals from the USFW, Arizona Land and Water Trust, Pima County Board of Supervisors, and Pima County Regional Flood Control Board of Directors. All concurred that the release does not compromise the County's ability to remain in compliance with the County's Section 10 incidental take permit. The release of this 1.15 acres lying at the western tip of parcel 219-20-9180 was to allow the construction of an access road from Tangerine Road into a development on private property abutting the restricted property in order to address traffic safety requirements.

