Inventory and Status of Unsupplemented and Perennial Surface Water on Pima County Open-space Properties

July 18, 2011

Brian Powell
Pima County Office of Sustainability and Conservation

Introduction

It is cliché to assert that water is an essential ingredient of life, but even in times of average precipitation in desert environments, water is the single most limiting factor for growth and distribution of natural resources such as plants and animals. Of course, the presence of surface water, in particular, is essential for a host of aquatic animal species such as fish and aquatic invertebrates, but is also important for many—but not all—terrestrial vertebrates (Cutler and Morrison 1998, Rosenstock et. al. 2004, O'Brien et. al. 2006). The need for surface water is particularly acute during extended periods of high temperatures, such as occurs in Pima County, Arizona from May through September of each year.

Surface water became a particularly scarce resource in southern Arizona between September 2010 and early July 2011, one of the driest "winter" rain periods in the area's history (Figure 1). During a time when an average of over one half the annual precipitation is received, some areas of Pima County received no measurable precipitation (Pima County, *unpublished data*), while other areas received only about one third of the normal precipitation.

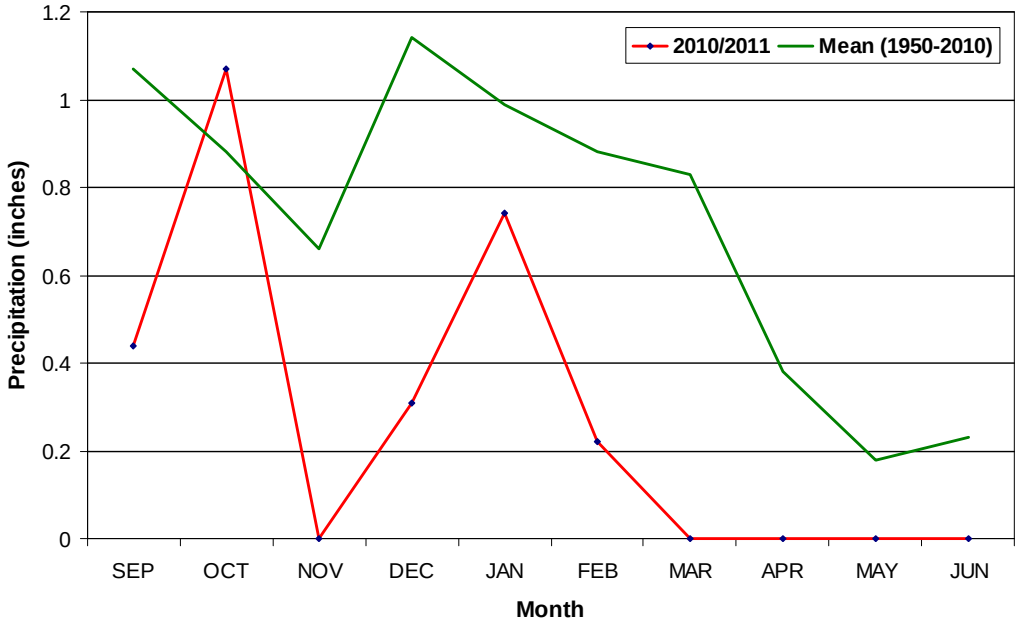

Figure 1. Monthly precipitation totals for Tucson from September 2010 through June 2011 (red line) as compared to normal (green line). Note that below-normal precipitation was recorded for all but one month during this period.

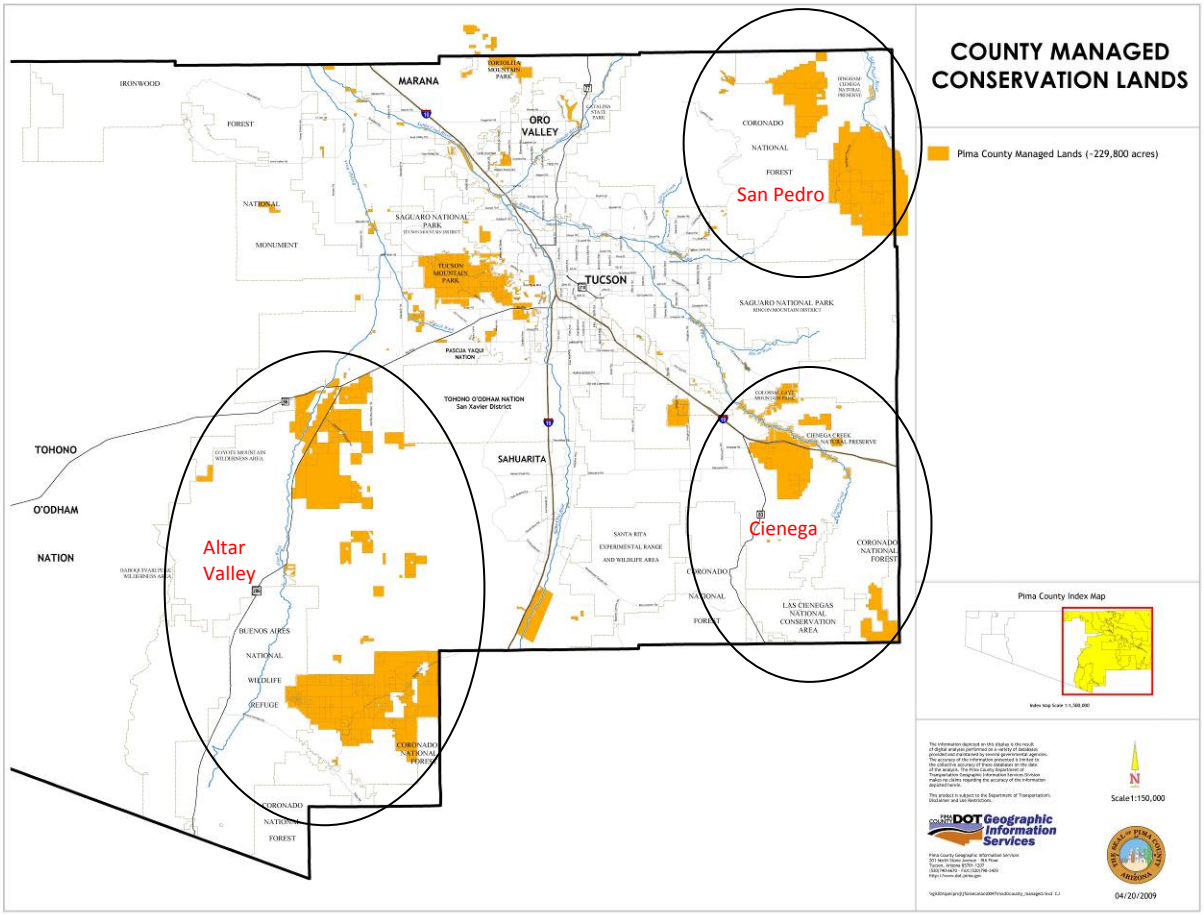

Figure 2. Network of Pima County owned and leased lands. Most of these lands were acquired or leased as a result of the 2004 voter-approved bonds. Circled areas refer to the watershed areas that are referenced in this report.

Pima County has recently taken on huge land and resource management responsibilities with the acquisition and lease of over 225,000 acres of land in eastern Pima County, with much of the land being acquired in the last six years (Figure 2). Since acquiring these lands, Pima County has set about to collect information on the location, status, and trends of key natural resources and threats to those resources. Efforts to date have included mapping key invasive species, monitoring rangeland condition, and monitoring water levels in select riparian areas. One key resource that has not been received attention is an inventory of perennial surface water resources, with particular emphasis on surface water that is not dependent on human-built water-delivery tools such as wells, pipes, and pumps. I call these "unsupplemented" water sources, and these are the focus of this report.

The extreme drought conditions of 2010/2011 provided an extraordinary opportunity to map unsupplemented and perennial water on County open-space parcels by identifying those sites

that retained water for wildlife and other resources throughout the drought. ("Sites" include earthen stock tanks, stream reaches, tinajas [bedrock pools], and springs). This is important for planning because if water remains at a site after nine months with little or no precipitation, there is a good chance that such a site will provide water in future droughts, and thereby become a critical refugium for the host of animals and plants that rely on this limited resource. Sites with perennial surface water are expected to become even more important under climate change scenarios that predict hotter temperatures and less rainfall for the region (Christensen et. al. 2007, Seager et. al. 2007).

Methods

The goal of the project was to inventory unsupplemented water at sites that maintained water throughout the drought of 2010/2011 and until the onset of summer monsoon rains. Therefore, I began this project by researching all known or suspected unsupplemented water sites within County open-space properties (herein County properties, which excluded most properties that are managed by the Pima County Regional Flood Control District). I used information collected during the development of the SDCP (e.g., Fonseca et. al. 2000), U.S. Geological Survey 7.5 minute quadrangle maps, aerial photographs, and I queried County staff and others whom are familiar with the properties. I included the Buehman Canyon property because the County will take over ownership of it in September 2011.

Starting from that list of potential sites, I set about to visit as many as possible beginning in the second week of June and continuing through the start of the monsoon, which was the first week of July for most sites. I postponed field visits for as long as possible because I wanted to know the condition of each site at the height of the hot, dry period before the start of the monsoon. Ideally the project would have taken place during the last week of June (i.e., at the very height of the drought), but this was not possible due to personnel constraints.

Field visits were most often made by me and another person, but for some sites I relied solely on observations by other County staff, and in the case of the Cienega Creek Preserve, by staff from the Pima Association of Governments (PAG). Though not the focus of this effort, I also documented sites outside—but in close proximity to—County properties and sites that contained supplemented water such as wells with drinking troughs and pipeline-fed tanks.

Characteristics that were recorded at sites included the condition of the water (clarity, smell, flowing, etc.) and location (UTM NAD83 using a hand-held GPS receiver). I recorded if there were aquatic or semi-aquatic vertebrates such as fish, leopard frogs, canyon tree frogs, Sonoran mud turtles, and black-necked garter snakes. I took a photograph (or multiple photographs) of all sites I visited and/or relied on photographs from others. Based on these findings and on an understanding of the conditions between the time of the visit and the onset of the monsoon, I estimated whether the site would have maintained water until the start of the monsoon. This determination was made based on amount, condition, context of the water source (e.g., bedrock versus sandy wash), and date of visit. For example, I visited Geesaman Wash two weeks prior to the start of the monsoon. Very shallow water was present in just a few bedrock

areas and there was no active flow. Therefore, I determined that the presence of water at the start of the monsoon was "unlikely."

Results

County staff and others visited 25 sites between June 8 and July 15, 2011 (Table 1). In total, ten sites contained water at the time of the survey and were thought to have maintained water until the start of the monsoon; four sites contained water at the time of the survey but were "unlikely" to maintain water until the start of the monsoon; and 11 sites did not have water at the time of the survey.

There was a disparity among watersheds based on the number and type of sites that maintained water. The Altar Valley, which has the largest land area of County properties among watersheds (see Fig. 2), had two sites that maintained water (all human-made stock tanks), while the San Pedro watershed had six sites (Table 1). All of the San Pedro sites were either springs or tinajas.

Not surprisingly, the site with the most water (as measured by extent) was Cienega Creek at the Cienega Creek Preserve, with surface water present along approximately 2.3 km of the Creek (PAG, *unpublished data*). Youtcy Spring was also an important site; the spring-fed surface water was present for approximately 400 m of the canyon bottom (Fig. 2). Three earthen tanks, created for cattle, proved to be important sources of water, especially in the Altar Valley, where the tanks were the only source of unsupplemented water (Fig. 3). Finally, tinajas and pools in canyon bottoms made up the majority of sites with water in the San Pedro watershed (Fig. 4). In one tinaja in Espiritu Canyon we encountered numerous animals trapped due to the low water level (Fig. 5).

In addition to visiting sites on County properties, we also visited three sites that were close to County properties (Table 2), and all of them were likely to contain water until the onset of the monsoon. We also visited a number of supplemented water sources (wells and pipeline) on County properties (Table 3). Not surprisingly, many of these sites contained water. Due to time constraints, we were unable to visit four unsupplemented sites that may have maintained water until the start of the monsoon: Honey Moon Ridge Tank and Horseshoe Dam (Rancho Seco), Turney Spings (Sands Ranch), and Becky Springs (Bar V Ranch). These sites will be visited in future surveys.

Table 1. Survey results at unsupplemented water sources on Pima County open-space properties.

Watershed/ Reserve	Property	Site Name	Water/ Structure type	Date Visited	Obser-ver(s)	Results/Condition at time of survey	Water present at the start of monsoon?	Notes
Altar Valley	Rancho Seco	Round (Cerro Colorado) Tank	Tank	6/23/2011	BP, DS	Dry	No	
		Pescada Tank and adjacent riparian zone	Tank	6/23/2011	BP, DS	Dry	No	Had not been dry for long
		Hopkins Tank	Tank	6/23/2011	BP, DS	Water present; pool approximately 50x20 feet, at most 3-4 feet deep	Yes	
		Compressor Tank	Tank	6/23/2011	BP, DS	Dry	No	
	Sopori Ranch	MP 15 riparian	Stream reach	6/24/2011	BP, IR	Dry	No	Most likely an ephemeral stream reach. Riparian vegetation (ash and hackberry) was very stressed
		Steer Pasture Tank	Tank	6/20/2011	IR	Water present; pool approximately 100x70 feet, unknown depth	Yes	
		Papalote Tank	Tank	6/24/2011	BP, IR	Dry	No	
Cienega Valley	BarV Ranch	Spring in Davidson Canyon	Spring	6/28/2011	BP	No water present and had not been for quite some time	No	Often a small pool of water will be present, which contained longfin dace and leopard frogs in the past. Also walked from spring to Davidson Canyon junction with I-10
	Cienega Creek Preserve	Cienega Creek	Stream reach	6/8/2011	PAG	Water found on approximately 2.3 km of stream	Yes	Mapped and surveyed for perennial water by PAG and others
	Sands and Clyne Ranches	Blacktail Spring	Spring	6/9/2011	BP, DH	Very small pool of clear water.	Unlikely	Because of its location in the creek bottom, it is not possible to develop; would be buried by debris
		Hospital Tank	Tank	6/9/2011	BP, DH	Water present	Yes	Recently modified to increase capacity and structural integrity. Has not gone dry since the 1950's
		MacNally Tank	Tank	6/11/2011	JS	Water only about 4 inches deep.	No	Will not hold water until start of the monsoon
San Pedro River	A7 Ranch	Youtcy Spring	Spring	7/1/2011	BP, DC	Excellent spring and lots of flowing water on approximately	Yes	Lowland leopard frogs present

Watershed/ Reserve	Property	Site Name	Water/ Structure type	Date Visited	Obser-ver(s)	Results/Condition at time of survey	Water present at the start of monsoon?	Notes
San Pedro River cont.	A7 Ranch Cont.					400m of above-ground flow		
		Robles Spring	Spring	7/15/2011	BP, DC	A few pools of water and slow trickle	Yes	
		Big Tank	Tank	6/15/2011	Barry	Tank was dry by 6/16/11	No	
		Riparian Area above and below Youtcy Ranch	Stream reach	7/2/2011	BP, DC	No water found	No	There is a capped well for potential future use
		Espiritu Canyon-Tinajas	Pool/Tinaja	6/30/2011	BP, DC	Two tinajas, one about 6x6 feet, 5 feet deep, the other 8x5 feet, about 3 feet deep.	Yes	Once tinajas contained many live and dead animals. See Figure 5.
		Buehman Canyon-A7	Stream reach	7/5/2011	BP, DS	No water in Pima County portion of A7 lease	No	However, water was present in adjacent parcels (see Table 2)
		Youtcy Canyon-Tinajas	Pool/Tinaja	7/1/2011	BP, DC	Two tinajas, one about 15x15 feet, 5-6 feet deep, the other 3x4 feet, 1 foot deep	Yes	
		Grapevine Spring	Spring	6/15/2011	Barry	Flowing water	Yes	
	Six Bar Ranch	Parker Homestead Spring	Spring	7/15/2011	BP, DC	Dry	No	Had been dry for quite some time
	Buehman Canyon	Riparian Area	Pool/Tinaja	6/21/2011	BP, CA	Water present in two small pools at this site. Very shallow pools with no flowing water.	Unlikely	Lowland leopard frogs and longfin dace present
		Bullock Canyon	Pool/Tinaja	6/21/2011	BP, CA	2 pools with water, approximately 50-60 square feet	Yes	One pool is likely to maintain water until monsoon. Lowland leopard frogs and longfin dace present. Area is part of impoundment by by human-made dam.
	Oracle Ridge	Geesaman Wash	Pool/Tinaja	6/17/2011	BP	Very little water; only a few stretches of water that had huge quantities of algae. Some pools possible anoxic.	Unlikely	Lowland leopard frog tadpoles present in some pools, but black-necked garter snakes were actively eating them.
		Tributary to Gibb Wash	Pool/Tinaja	6/17/2011	BP	Just a few scattered pools on Pima County portion.	Unlikely	Water flowing from below mine at about 1-3 gal/minute, but on County land, just about 45m stretch of flowing/stagnant water.

[a] BP = Brian Powell; DS = Doug Siegel; IR = Iris Rodden; DC = Don Carter; JS = John Sullivan; DH = David Hall; CA = Celeste Andresen; PAG = Pima Association of Governments.

Table 2. Site close to—but not on—Pima County properties that were visited as part of this project.

Watershed/ Reserve	Property nearest to site	Site Name	Water type	Owner-ship	Date Visited	Obser-ver(s)[a]	Results/Condition at time of survey	Water present at the start of monsoon?	Notes
Cienega Valley	Sands and Clyne ranches	Clyne Pond	Tank	BLM	6/9/2011	BP, DH	Dry	Likely	Drained in December 2010 to rid tank of crayfish, otherwise it would likely have water
		Spring above Clyne Pond	Spring	BLM	6/9/2011	BP, DH	Water flowing into 2 pools, water clear	Likely	
San Pedro	A7/Buehman	Buehman Canyon	Spring/ stream reach	State/pri vate	7/5/2011	BP, DS	Lots of water on private parcel next to state lease	Yes	Large pools and braided stream with lots of water. Hundreds of lowland leopard frogs and thousands of longfin dace. Also, a few sites further downstream (state land) with discrete pools.

[a] BP = Brian Powell; DH = David Hall; DS = Doug Seigel.

Table 3. Sites with supplemented water on County open-space properties. The database of these sites will be expanded in the future to include all wells and wildlife drinkers.

Watershed/ Reserve	Property	Site Name	Water type	Date Visited	Obser-ver(s)[a]	Results/Condition at time of survey	Water present at the start of monsoon?	Notes
Altar Valley	Rancho Seco	Horse Apple Well	Well, trough, and stream Reach	6/23/2011	BP, DS	Trough was full	Yes	
		Martinez Well	Well	6/23/2011	BP, DS	Some water, but very slow	Yes	Solar powered
		Ramosa Well	Well and trough	6/24/2011	BP, IR	Water present	Yes	
	Sopori	Cemetery Well	Well	6/24/2011	BP, IR	Water present	Yes	Fair amount of water coming from well
Cienega	Sands and Clyne ranches	Maverick well	Well	6/11/2011	JS	Dry	No	Water 10 feet underground in open well
		Ramsey Well	Well	6/9/2011	BP, DH	Dry	No	Well depth at 250 feet. Will be modified to supply water to Chiricahua leopard frogs
		Goat Well	Well	6/9/2011	BP, DH	Dry, but being piped away	No surface water	Pipeline feeds sites further east, including Cottonwood Spring.
San Pedro	Oracle Ridge	Earthen tanks	Tank w/pipeline	6/17/2011	BP	Three tanks full of water and actively being filled.	Water present	Tank being filled by rancher via a pipeline. Many leopard frogs in two pools

[a] BP = Brian Powell; DS = Doug Siegel; IR = Iris Rodden; JS = John Sullivan; DH = David Hall.

Figure 2. Youtcy Spring feeds the lush riparian area along the canyon bottom (left) and provides excellent large pools of water for wildlife, including hundreds of lowland leopard frogs (right) and tadpoles.

Figure 3. Earthen tanks, which are created for cattle, can provide an important source of unsupplemented water for wildlife. Pictured here is Hopkins Tank on Rancho Seco (left) and Steer Pasture Tank on Sopori Ranch (right).

Figure 4. Pools, either in sandy creek bottoms (Buehman Canyon; left) or in bedrock (Youtcy Canyon, right) are important for wildlife. At both of these sites there was extensive sign of wildlife activity.

Figure 5. Individuals on this "life raft" within a tinaja in Espiritu Canyon (A7 Ranch) are trapped because the water level is too far below the lip of the tinajas for them to escape. Individuals on the stick, from left to right: Sonoran mud turtle, Sonoran whipsnake, lowland leopard frog, Sonoran whipsnake, and Sonoran desert toad. Note the Gila monster to the left of the stick. All of these animals were rescued.

Discussion

Summary

This project builds on a long history of data collection on riparian and aquatic features in Pima County as part of the SDCP (e.g., Fonseca et al. 2000, Pima County 2000, Rosen 2000, Pima County 2002). Now that Pima County manages such a large land base, it is important to step down the level of information from regional assessments to property-specific resources so that this information can be used for planning purposes. In this regard, considerable attention has been paid to the surface water resources at the Cienega Creek Preserve (Fonseca 1993, McGann and Associate Inc. 1994, Pima Association of Governments 2001, 2009). This study was the first to expand the scope of the wet-dry mapping at the Cienega Creek Preserve to Pima's County's other open space properties.

The results of this effort show that unsupplemented surface water sites are rare on County open-space properties during times of drought. Assuming that the ten sites that contained water are an accurate census, this equates to an average of approximately one source of

perennial water for every 20,000 acres of County open-space property. In the Altar Valley this estimate increases to one site for every 50,000 acres. Clearly, these sites are a valuable resource within the County's land management portfolio.

Though the focus of this report is on those sites that held water the longest during the severe drought of 2010/2011, this does not discount the importance of sites with intermittent or ephemeral surface water. These areas can be crucial resources for a wide range of resources. For example, ephemeral surface water, which sometimes remains for only a few weeks, is used almost exclusively by most of the desert toads (family Bufonidae). These surface water resources play critical a critical role in a host of ecosystem functions such as dispersal of aquatic animals, nutrient cycling, and sediment movement. A full treatise of these resources may be the subject of future reports.

Climate Change

The results of the extreme drought conditions documented in this report are likely to become more common due to climate change. Based on a set of assumptions about the future release of greenhouse gases, global climate models predict an increase of between 3.2°F to 7.2°F in the next 100 years (Meehl et. al. 2007), with current consensus among scientists for an average global increase of at least 5.4°F in the next 100 years. Regional models predict a 10-20% reduction in precipitation in the Southwestern U.S. and northern Mexico in the next 75 years (Christensen et al. 2007), with most reductions in precipitation during the winter months when circulation patterns over the Pacific Ocean prevent moisture from entering the region through a movement of the storm track to the north. This will leave southern Arizona more arid, a pattern that is particularly severe during years when La Niña patterns predominate (Seager et. al. 2007), which occurred in 2010/2011. Overall, the climate of Pima County will be hotter and dryer with more extreme periods of high temperatures and extreme weather events. To make things worse, higher average temperatures will have the effect of lowering effective rainfall because of greater evaporation and evapotranspiration. Recent work by The Nature Conservancy indicates that moisture stress (annual evaporation minus precipitation) on plants from 1970-2006 led to an effective decrease in precipitation of approximately 1/3 inches over much of Pima County (Rob Marshall, *unpublished data*).

Given the anticipated effects of climate change on natural resources in Pima County, it will be critical for Pima County to consider the impact of prolonged and severe droughts in management decisions such as restoration projects, the ranch management program, and ensuring that water is available for wildlife. Powell (2010) provided an in-depth discussion of management responses to climate change, but in general, the umbrella concept of *adaptation* is central to any discussion of management response to climate change. In this context, adaptation refers to adjusting management actions in the face of changing climatic conditions. The first line of defense in climate change adaptation is to create *resistance* to change. This often involves efforts at reducing or mitigating impacts of a non-climate threat on resources that are likely to be affected by climate change. Examples include fencing of sensitive areas; creating fire breaks; establishing new, year-round water sources; or adding water to aquatic or riparian systems. Promoting resistance provides a reduction in a threat before it has a chance

to test the capacity of a system to withstand change. The main criticism of resistance strategies is that they can be seen as simply "buying time," and thereby ignores the underlying fundamentals that will put even more climate-induced stress on the system in the future.

Management Actions and Future Steps

The information in this report can serve a number of management actions. First, protection and enhancement of natural, 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. Therefore, data on the location and status (and eventual trends) of these resources can provide a starting place for discussions about management actions that might enhance, protect, or buffer these resources from climate change. Also, this information can be used when making decisions about locating alternative water sources such as wells and water catchments for cattle and wildlife, a topic of considerable interest and debate among wildlife scientists and managers. This is also a topic for a future report. Finally, the data in this report will be valuable when Pima County begins to develop the Riparian and Aquatic Management Plan, which is a required element of the forthcoming Section 10 permit.

This inventory was a first step in gathering water availability data on County open-space properties. Additional work is needed, including:

1) During the next drought, visit the four sites that were not visited as part of this effort;
2) Continue to collect information on all potential sites, including select ephemeral and intermittent sites;
3) Inventorying all water sources on County lands and adjacent lands (where feasible and permissible), including wells and pipelines;
4) Monitoring select site and develop a database for this information. Some of this work will take place as part of the County's forthcoming Ecological Monitoring Program, which will monitor key species, habitat elements (including water), threats, and landscape pattern. Information about this program can be found on the MSCP website.

Acknowledgements

This project would not have completed without the help from a host of people who either accompanied me on the field excursions or provided data for the effort: Celeste Andresen, Don Carter, David Hall, Rachel Loubeau, Mead Mier, Iris Rodden, Doug Siegel, and John Sullivan. Julia Fonseca provides important background material, context, and support for this work. She also improved an earlier draft of this report.

Literature Cited

Christensen, J. H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R. K. Kolli, W.-T. Kwon, R. Laprise, V. M. Rueda, L. Mearns, C. G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton.S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, Eds. 2007. Regional climate projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth

Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Cutler, T. L., and M. L. Morrison. 1998. Habitat use by small vertebrates at two water developments in southwestern Arizona. The Southwestern Naturalist 43:155-162.

Fonseca, J. 1993. Hydrologic availability and use of streamflows at the Cienega Creek Natural Preserve, Pima County, Arizona. Prepared for the Arizona Department of Water Resources by Pima County Flood Control District, Tucson, AZ.

Fonseca, J., D. Scalero, and N. Connolly. 2000. Springs in Pima County, Arizona. Report to the Pima County Board of supervisors for the Sonoran Desert Conservation Plan, Tucson AZ. Tucson, AZ.

McGann and Associate Inc. 1994. Cienega Creek Natural Preserve Management Plan. Prepared for the Pima County Regional Flood Control District. Tucson, AZ.

Meehl, G. A., T. F. Stocker, W. D. Collins, P. Friedlingstein, A. T. Gaye, J. M. Gregory, A. Kitoh, R. Knutti, J. M. Murphy, A. Noda, S.C.B. Raper, I. G. Watterson, A. J. Weaver, and Z. C. Zhao.S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, Eds. 2007. Global Climate Projections. In: Climate Change 2007: The Physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

O'Brien, C. S., R. B. Waddell, S. S. Rosenstock, and M. J. Rabe. 2006. Wildlife use of water catchments in southwestern Arizona. Wildlife Society Bulletin 34:582-591.

Pima Association of Governments. 2001. Bingham Cienega source water study. Report to the Pima County Board of Supervisors for the Sonoran Desert Conservation Plan, Tucson, AZ.

Pima Association of Governments. 2009. Cienega Creek Natural Preserve surface water and groundwater monitoring. Annual report for the 2007-2008 fiscal year. Unpublished report to the Pima County Regional Flood Control District, Tucson, AZ.

Pima County. 2000. Riparian protection, management and restoration: An element of the Sonoran Desert Conservation Plan. Report to the Pima County Board of Supervisors for the Sonoran Desert Conservation Plan. Tucson, AZ.

Pima County. 2002. Riparian priorities in Pima County. A report to the Pima County Board of Supervisors for the Sonoran Desert Conservation Plan. Tucson, AZ.

Rosen, P. C. 2000. Aquatic vertebrate conservation in Pima County: Concepts and planning development. Draft report to the Pima County Board of Supervisors, Tucson, AZ.

Rosenstock, S. S., M. J. Rabe, C. S. O'Brian, and R. B. Waddel. 2004. Studies of wildlife water developments in southwestern Arizona: Wildlife use, water quality, wildlife diseases, wildlife mortalities, and influences on native pollinators. Research Branch Technical Guidance Bulletin, Arizona Game and Fish Department, Phoenix, AZ.

Seager, R., M. F. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H. P. Huang, N. Harnik, A. Leetmaa, N. C. Lau, C. H. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 316:1181-1184.