New research proposal to Western National Parks Association

The information supplied should be limited to the space provided and submitted on these forms. A proposal received in any other format will be returned. Additional attachments are not permitted.

Title of Project: **Are springs and tinajas in Saguaro National Park threatened by groundwater withdrawal outside the park?**	Park(s) in which research is to be conducted: Saguaro National Park
Name, address and phone number of principal investigator(s): Don Swann, Saguaro National Park, 3693 South Old Spanish Trail, Tucson, AZ 85730 (520) 733-5177. Colleen Filippone, NPS Intermountain Regional Hydrologist, 12661 E Broadway Blvd. Tucson Arizona 85748 (520) 403-2527.	Payee information - individual name and address or institution's name and address required: Saguaro National Park, 3693 South Old Spanish Trail, Tucson, AZ 85730
Is this a multi-year project? ☐ YES | NO ☑ Total amount requested: This year $ 7,365 If multi-year project, estimated amount: 2nd year $ _____ 3rd year $ _____	Desired start date: November 1, 2016 Note: Not prior to October 1st
Project Duration: 1 year Project final completion date: November 1, 2017 (see Research Guidelines)	
Name(s) of research participant(s) who will acquire advanced degree(s) as a result of working on this project, if any:	Product(s) of research (articles, theses, maps, checklists, etc.) in addition to final report to WNPA (see research guidelines): Technical report and peer-reviewed scientific paper

Abstract to be provided by PI(s). Do not exceed the half-page space provided below.

Given the ultimate value of water in the desert for both people and wildlife, Saguaro National Park and our scientific partners have been studying the park's intermittent streams, springs, and spring-fed stream pools called tinajas for more than 10 years. Due to the potential for groundwater withdrawal to affect wildlife habitat in Rincon Creek, we have had an active water rights case on the creek since 2003. Recently, a meta-analysis of groundwater chemistry from the park suggests that the source of water in some springs and tinajas is a deep mountain-block scale aquifer that extends beyond the park boundaries and is subject to active groundwater pumping. In 2016 we initiated a long-term project to collect samples at key times during the year to better understand the chemistry – and origins – of the park's waters. However, we do not have sufficient funds to analyze the full suite of parameters needed for the number of samples we would like to collect. Our proposed request to WNPA is for funds for water chemistry analysis, as well as for mule packing support for high elevation hydrological work. Park interns will collect the samples, and park staff and the NPS regional hydrologist will work with our scientific partners from the UA isotope laboratory and a certified Arizona water quality testing laboratory to conduct analyses and interpret the results. This project will also partially support a Next Gen Ranger intern who will interpret the park's waters through interpretive programs, social media, creation of a water video for the Visitor Center, and development of an innovative cell phone-based Citizen Science monitoring program. The results of this project are essential for the park to develop long-term management strategies for protecting one of our most vulnerable resources in the face of Tucson's growing population, declining precipitation, and rising temperatures in Arizona's Sonoran Desert.

(1) JUSTIFICATION (to be provided by submitting park): This section should specify the following: 1) Are NPS-appropriated funds available for the project (Yes/No)? 2) Where does this project rank in NPS and the submitting park's research priorities? 3) Was this proposal solicited by the park? 4) How will this research enrich visitors' understanding of the park? 5) What are the implications for resource management?

This project will provide Saguaro National Park with data that are essential for protecting the park's rare and unique water resources. Information gathered over the past 10+ years, with support from WNPA and the Friends of Saguaro National Park, and scientific partners from the University of Arizona and US Geological Survey, reveal not only the value that springs and spring-fed stream pools in the park hold for both aquatic and terrestrial wildlife, but that for at least some of them, base flow – water that is critical for wildlife during the driest times of the year – likely originates in a regional aquifer that is vulnerable to the effects of groundwater overdraft.

1) Through our internship programs, the park has the resources to gather samples that are needed to further study the relationship between surface water in the park and aquifers beneath and just outside the park, but we do not have funding for full water chemistry analyses that will help reveal which water sources are most vulnerable. This WNPA proposal would provide support for these analyses as well as mule packing support that will allow our interns and staff to transport equipment to high elevation roadless Wilderness areas.

2&3) The proposal originated in the park's Resource Management division and is our highest priority for funding in 2017. The funds would come to the park, and we will use them to pay the University of Arizona isotope lab and water quality testing laboratories. NPS hydrologist Colleen Filippone and UA and USGS scientists will work with us to interpret the results and develop a technical report and peer-reviewed scientific paper.

4) Educating visitors about water at the park is an important part of this project. We find that people – not only back-country campers who depend on water, but even casual visitors who live in Tucson – are amazed and appreciative of desert waters when they learn about them. We will expand a Citizen Science water monitoring program that will allow hikers to use new cell phone technology to exchange information with park staff on the changing status of water in springs to the park. We will also use social media to instill an appreciation of desert waters in our people who may only appreciate the park from afar, and we will create a water video for the science corner of the Visitor Center. Water is an essential part of the Sonoran Desert, and we want to engage people who will help us protect it for future generations. The visitor experience will be enriched by providing an opportunity to share observations via the Citizen Science aspect of the project; the visitor understanding will be enriched by both the social media outreach and by the incorporation of results (directly or indirectly) into the video and educational presentations. Park staff are making progress but have many questions remaining about the function of groundwater systems that supply springs and long-lasting pools through the dry season. Chemistry and isotopes have proven to be the most useful tools in developing the needed conceptual models.

5) Successful resource management depends on understanding the forces affecting resource condition and change. Water is a fundamental resource that shapes the physical environment and upon which all life depends. The implications of an evolving understanding of the processes governing groundwater and surface water resources at the park touch all resources, in that threats and opportunities can be anticipated and handled more appropriately.

(2) CONCISE STATEMENT OF RESEARCH OBJECTIVES, DESIGN, AND METHODOLOGY. This section should include the facilities and sites to be used. Note: Limit this section to the two pages provided.

Water in the arid American Southwest is a precious commodity that is in increased demand as human populations grow. At the same time, the amount of available water is expected to decrease with higher regional temperatures and less snow pack in mountain areas (Seager et al. 2007). In Saguaro National Park, water can be abundant following heavy rainstorms, but during most of the year it can very hard to find. Hikers and campers in the park's Wilderness depend on springs and spring-fed stream pools called tinajas. These scattered and often-hidden sources are essential for survival of aquatic species such as the sensitive lowland leopard frog (Zylstra et al. 2015) but also for many birds and mammals that must drink every day.

Because of the great value of desert water, potential loss of water in Rincon Creek due to groundwater pumping (NPS 2008), apparent decreases in water available in high elevation springs (Gaun et al, in review) and the potential for recharge to decrease with climate change (Meixner et al., 2016), NPS scientists have been studying water in the park for >10 years. Using volunteer citizen scientists and interns, including from the local NGOs such as the Sky Island Alliance, we currently track water levels in springs and tinajas and use data loggers to monitor groundwater in wells and streams (Swann et al. 2016). We recently completed an inventory report on springs in the park (Gaun et al., in review) that included making all of our spring data available on-line to the public through the Springs Stewardship Institute database (http://springsdata.org/), and have started a preliminary assessment of the cultural resources associated with springs in the park. We also have been working with NPS hydrologists and partners from the University of Arizona and U.S. Geological Survey to study water chemistry to better understand the origin of park waters (Eastoe 2012). This year, we contributed to comprehensive reports on water resources for the park's Natural Resource Condition Assessment (NRCA; NPS, in press).

As part of the NRCA, NPS regional hydrologist Colleen Filippone completed a meta-analysis of all of the water quality data collected in and near the park over the past few decades (Filippone, in review). Results of this study confirm that while water in high elevation springs is relatively "new" in that it has recently fallen as rain or snow, at least some of the water in low elevation springs and tinajas is quite old, and water chemistry including high values of fluoride and chloride indicate they may be connected to a larger regional aquifer that is accessed by a large number of production wells outside the park (Love et al. 2014). Aqua Caliente Spring, an important water source outside the park also associated with this aquifer, has experienced declines in recent years and even went dry for a period of time (Love et al. 2014).

The age and origin of water that occurs in places like Saguaro National Park is of conservation interest because while newer waters are quickly replaced by rain and snow, older waters may have accumulated slowly over time (Konikow 2013). Water extraction for domestic use and agriculture may exceed the rate at which they are replenished, leading to lowering of the water table and potential draining of the aquifer. Millions of people around the world, especially in arid regions, depend on "fossil waters" that may be tens of thousands of years old, but are essentially a non-renewable source like oil (Handwerk 2010). In parts of the US, the large volume of depletion of these waters is a serious problem because much of the loss cannot be easily recovered and it affects the sustainability of water supplies and streams (Konikow 2013).

Scientists can determine the age (residence time) and origin of water using stable isotopes, which are essentially forms of the same element that have variable numbers of neutrons in their nuclei. For example, winter and summer rains each have distinctive signatures for oxygen and hydrogen isotopes. A common isotope used to determine the date of when water originally fell as rain is tritium, an isotope of hydrogen that occurs naturally on earth in very small amounts, but was released in massive quantities during atmospheric testing of nuclear weapons in the 1950s and early 1960s. Very low tritium levels in Douglas Spring and several tinajas along the park boundary suggest that these waters are at least 50 years old and may be much older (Eastoe 2012, Filippone in review).

Methods

We will collect water in perennial springs and tinajas along an elevational gradient and analyze water chemistry for comparison with published and reported values (Eastoe 2012, Filippone in review) to determine age, origin, and relationship with other waters. Because it is important that water samples be taken directly from the spring source, we will pump water out of the springs to a nearby catchment, then collect the water that refills the source. We successfully piloted this project in 2016 and have completed environmental compliance to continue it.

(2) CONCISE STATEMENT OF RESEARCH OBJECTIVES, DESIGN, AND METHODOLOGY (Cont'd):

We will sample from at least 3 key springs and tinajas near the Rincon-Catalina detachment fault (Rock Spring and several tinajas), as well as at least 8 springs and tinajas along an elevational gradient from approximately 3,000 feet in elevation to 8,000 feet in elevation. Most sources will be sampled once, but at least one representative source will be sampled 3 times to determine potential seasonal variation in water chemistry. We will analyze seasonality of water through stable oxygen and hydrogen isotopes, and determine age using tritium isotopes. Stable water isotopes of each precipitation event in the Rincon Valley are being analyzed for a separate PhD dissertation (D. Winkler, Univ. of CA at Irvine; also supported by WNPA) and will be incorporated into this analysis. All isotope analysis will be done by the UA Environmental Isotope Laboratory, Dept. of Geosciences. We will determine source and water type through analysis of basic ions (chloride, fluoride, sulfates, bicarbonate, calcium, potassium, sodium, magnesium, etc.), cation/anion balance, total dissolved solids, alkalinity and other measures. Water chemistry analysis will be done by TestAmerica Laboratories (Arvada, CO and Phoenix, AZ) or a similar lab.

We will prepare a final report with management implications in consultation with geochemists and hydrologists from UA (D. Dettman, G. Davis) and USGS (K. Beisner) that will place the results in a full conservation context and include management implications for Saguaro National Park.

Literature cited

Eastoe, C.J. 2012. An isotope study of groundwater in and around Saguaro National Park, Rincon Mountain District, Tucson, Arizona. Unpublished report prepared for the National Park Service. October, 2012. 28 pp.

Filippone, C. Groundwater. In review. Chapter in Saguaro National Park: Natural Resource Condition Assessment. Natural resource report NPS/SAGU/NRTR. National Park Service, Fort Collins, Colorado.

Gaun, J., D.E. Swann, E. Gwilliam, C. McIntyre, and L. Misztal. In review. Spring inventory for Saguaro National Park. Natural resource report NPS/SAGU/NRTR. National Park Service, Fort Collins, Colorado.

Handwerk, B. 2010. Underground fossil water running out. National Geographic News. http://news.nationalgeographic.com/news/2010/05/100505-fossil-water-radioactive-science-environment/. Accessed 28 August 2016.

Konikow, L.F., 2013, Groundwater depletion in the United States (1900–2008): U.S. Geological Survey Scientific Investigations Report 2013–5079, 63 p., http://pubs.usgs.gov/sir/2013/5079.

Love, D.S., B.F. Gootee, J.P. Cook, M.K. Mahan, and J.E. Spence. 2014. An Investigation of Thermal Springs throughout Arizona: Geochemical, Isotopic, and Geological Characterization, Arizona Basin and Range Province. Arizona Geological Survey Open-File Report -14-06, 129 p.

Meixner, T., A.H. Manning, D.A. Stonestrom, D.M. Allen, H. Ajami, K.W. Blasch, A.E. Brookfield, C.L. Castro, J.F. Clark, D.J. Gochis, A.L. Flint, K.L. Neff, R. Niraula, M. Rodell, B.R. Scanlon, K. Singha, M.A. Walvoord. 2016. Implications of projected climate change for groundwater recharge in the western United States. Journal of Hydrology 534 (2016) 124-138. http://www.journals.elsevier.com/journal-of-hydrology/open-access-articles.

Seager R.,Ting M, Held I, Kushnir Y, Lu J, Vecchi G, Huang H P, Harnik N, Leetmaa A, Lau N C, Li C. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science, 316(5828): 1181–1184.

Swann, D.E., N. Perkins, and K. O'Brien. 2016. Centennial science initiative for water and wildlife conservation in Saguaro National Park. Final report to Nina Mason Pulliam Charitable Trust, Phoenix.

Zylstra E.R., R.J. Steidl, D.E. Swann, and K. Ratzlaff. 2015. Hydrologic variability governs population dynamics of a vulnerable amphibian in an arid environment. PLoS ONE 10(6): e0125670. doi:10.1371/journal.pone.0125670.

3) CONCISE STATEMENT OF HOW YOUR RESEARCH CAN ENHANCE THE INTERPRETIVE MISSION OF THE PARK. ALSO INLCUDE ONE PARAGRAPH DESCRIBING THE PLAN FOR AN INTERPRETATION-RELATED PRODUCT OF THE RESEARCH. Use this page only.

An important goal of this project will be to give water and regional water conservation a higher profile at Saguaro National Park, and to increase public knowledge of the value and vulnerability of unique spring ecosystems in Arizona. We started this process during the past year, with our Next Gen interns (funded by the Friends of Saguaro National Park) using social media such as Facebook and Snapchat to highlight the park's unique waters in English and Spanish (for examples, see https://www.facebook.com/saguaronationalpark/videos?ref=page_internal) and create a water webpage (https://www.nps.gov/sagu/learn/nature/water-in-saguaro-national-park.htm) that includes information and teacher lesson plans. We have produced an interpretive booklet and developed educational programs for kids, including visits to tinajas with the Parks and Focus program and a citizen science program to collect dragonflies in order to study atmospheric mercury (http://www.nature.nps.gov/air/studies/air_toxics/dragonfly/index.cfm).

As part of this project, we will implement additional education programs for older (middle and high school) students. We will bring a minimum of 5 groups (approximately 10 students each) from under-represented schools out to the park to help us sample surface and groundwater and measure field parameters as part of the project. In addition, we will maintain and expand our water education website and produce a minimum of 10 social media posts related to this project and its results.

In addition to programs and social media posts, we will create or adapt a phone app that will allow visitors to directly share information on water sources in the park. Currently, campers and hikers can submit written reports on the status of water at springs through a slow process – the US mail or in person at the Visitor Center – which is then shared with hikers coming to the Visitor Center to obtain camping permits. This new system will allow information on water status to be more quickly disseminated so that visitors can have access to more recent information on the status of springs where they may be hiking. It will also provide a valuable information base for long-term monitoring, especially for springs that require very long hikes, such as Italian and Spud Rock springs.

A final product that we will create as part of this project will be a video on the value of water in Saguaro National Park for the Visitor Center Science Corner, similar to the videos we have recently made for the science of Gila monsters and saguaros in the park. This 3-5 minute video will create a strong sense of why water is such an important natural resource in the park and what we can all do to protect it.

(4) QUALIFICATIONS OF THE PRINCIPAL INVESTIGATOR(S) CONDUCTING THE RESEARCH. Use this page only. List only those qualifications directly related to this grant request. Include a list of other WNPA-funded research conducted by this PI.

Don Swann is a biologist at Saguaro National Park. Don has an MS in Wildlife Ecology from University of Arizona and an undergraduate degree in Biology-Geology from Brown University. He is an author or co-author on more than 25 peer-reviewed scientific papers. For both his science and Citizen Science activities in US national parks, Don has been the recipient of the NPS Director's Award for Excellence in Natural Resource Management (2006) and the Emil Haury Award from WNPA (2014). Don has been PI or co-PI on more than 15 WNPA-funded projects since 1994; in addition to being important for park management, most of these projects have produced peer-reviewed scientific papers. Don's most recent WNPA projects include: 1) Climate change impacts on the nurse-protégé relationships and the seasonality of water use of Saguaro cacti, Carnegiea gigantea, and the dominant tree species of Sonoran Desert (with Travis Huxman, 2015); 2) Using citizen science for long-term monitoring of Gila monsters (with Kevin Bonine, 2014); 3) Graduate student mini-grants for the 2011 BioBlitz (2011).

Colleen Filippone completed a Master's of Science in Hydrology and Water Resources at The University of Arizona under the advisement of Regent's Professor Shlomo Neuman, a world respected groundwater hydrogeologist. Her research focused on groundwater flow in fractured granite at a study site near Oracle, Arizona. As a consulting hydrologist, she has conducted groundwater modeling and field studies in the U.S. and Chile. Since she began working with NPS in 2003, Colleen has provided a wide range of hydrology services to parks in Arizona and New Mexico, with special focus on groundwater issues. She authored a WNPA report titled "Quantify soil-water percolation to Apache Spring, Fort Bowie National Historic Site, Cochise County, Arizona" in 2009, and has since submitted an expanded report on that research to the park as well as results of a subsequent study of water quality at springs and wells at Fort Bowie NHS. Colleen supports monitoring and reporting tasks for the Sonoran Desert Network groundwater monitoring protocol and recently completed an in-depth analysis of existing data relating to groundwater systems and processes at Saguaro National Park Rincon Mountain District for the NPS Natural Resource Condition Assessment program.

Budget for New Research Proposal

Project title and submitting park: Are springs and tinajas in Saguaro National Park threatened by groundwater withdrawal outside the park?

Personnel

Principal investigator(s)	Funds requested from WNPA	Cash or in-kind contribution (Please specify which and source.)
1 Don Swann (40 hrs x 48/hr = $1,920)	0	$1,920
2 Colleen Filippone (40 hrs x 56/hr = $2,250)	0	$2,250
3		

Other personnel (Specify number in brackets. Specify duties to be performed to earn funds on next page.)	Funds requested from WNPA	Cash or in-kind contribution (Please specify which and source.)
1 Next Gen Intern (42 hrs x 18.56/hr requested)	$780	$2,339
2		
3		
4		
5		
Total Personnel Costs	$780	$6,609

EQUIPMENT COSTS (List item and dollar amounts for those items costing more than $100 each on next page.)		
TRAVEL AND SUBSISTENCE (Itemize on next page.)	$800	

Other costs

1 Supplies and material		$100
2 Consulting services	$5,785	
3 Computer services		
4 Subcontracts (Itemize on next page.)		
Total Personnel Costs		$6,609

Total Personnel Costs If multiyear project, summarize estimated subsequent year(s) budget(s) on next page.	$7,365	

COSTS (Cont'd). Note: Be sure to explain here the duties that will be performed by any funded individual.

Budget breakdown

Cash or in-kind contributions:

Saguaro NP and NPS Intermountain region will support approximately 40 hours of in-kind time for Don Swann and Colleen Filippone ($4,170).

Saguaro and the Friends of Saguaro National Park will donate 126 hours of a Next Gen intern's time for field work and interpretive product development ($2,339).

NPS will supply collecting vials for water samples and other supplies ($100).

Requested from WNPA:

Next Gen intern time (42 hours @ $18.56 = $780.

Isotope analysis (hydrogen, oxygen, and tritium) by UA Environmental Isotope Laboratory (225/sample x 13 samples) = $2,925

Water chemistry analysis (basic ions, cation/anion balance, alkalinity, etc.) by TestAmerica or similar facility (220/sample x 13 samples, includes shipping and handling) = $2,860

Pack trip to Manning Camp to haul supplies, samples, and sampling equipment = $800

Total requested from WNPA = $7,365

A special note for researchers and the park superintendent:

WNPA is the funder of this grant on behalf of NPS, and WNPA handles selection, monitors progress, administers the payment schedule, and determines successful completion or default. WNPA also posts the final research report on its website, WNPA.org.

All other decisions regarding the conduct of this research grant (e.g., park access, laws, safety, protocols, etc.) and uses of the research, data, and its products (e.g., release of information, publication, intellectual property, etc.) rest in the hands of NPS and are the responsibility of NPS. Researchers and NPS should clarify any questions or assumptions before accepting the grant.

Due to several factors, ALL WNPA grants are for ONE YEAR ONLY (1 year only); however, we welcome and will carefully consider applications for second or third years following a successful first year.

Best wishes and hopes for a successful project. Thank you from WNPA.

I have read and agree to abide by the research guidelines in effect at the time of this application.

Signature of Principal Investigator(s) — Date: 8/31/16

Signature of Park Superintendent — Date: 8/31/16

Signature of Chief of Interpretation — Date: 8/31/16

For WNPA Use Only

WNPA Research Committee Review: Action and Date:

Amount Granted: