National Park Service

ARTICLE

Climate and Water Monitoring at Organ Pipe Cactus National Monument

Organ Pipe Cactus National Monument



Monsoon clouds over Organ Pipe Cactus National Monument. **NPS photo**.

Overview

Together, climate and hydrology shape ecosystems and the services they provide, particularly in arid and semi-arid ecosystems. Understanding changes in climate, groundwater, and surface water is key to assessing the condition of park natural resources—and often, cultural resources.

At Organ Pipe Cactus National Monument (NM) (Figure 1), **Sonoran Desert Network** scientists study how ecosystems may be changing by taking measurements of key resources, or "**vital signs**," year after year—much as a doctor keeps track of a patient's vital signs. This long-term ecological monitoring provides early warning of potential problems, allowing managers to mitigate them before they become worse. At Organ Pipe, we monitor **climate**, **groundwater**, and **springs**, among other vital signs.

Surface-water and groundwater conditions are closely related to climate conditions. Because they are better understood together, we report on climate in conjunction with water resources. Reporting is by water year (WY), which begins in October of the previous calendar year and goes through September of the water year (e.g., WY2021 runs from October 2020 through September 2021).

This article reports on results of climate and water monitoring done at Organ Pipe Cactus National Monument in water year 2021.

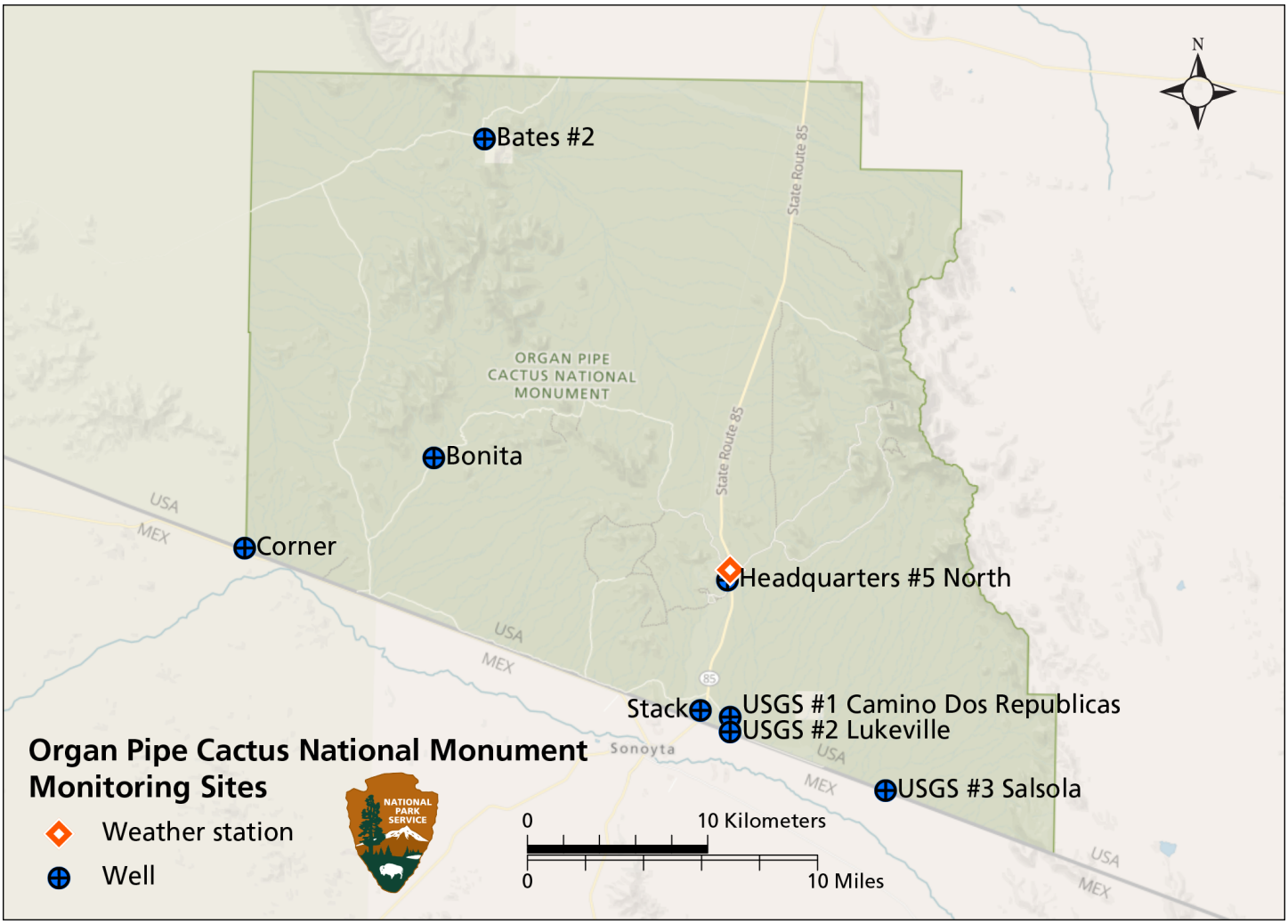


Figure 1. Monitored weather stations and groundwater wells at Organ Pipe Cactus National Monument.

Climate and Weather

There is often confusion over the terms, “weather” and “climate.” In short, ***weather*** describes instantaneous meteorological conditions (e.g., it’s currently raining or snowing, it’s a hot or frigid day). ***Climate*** reflects patterns of weather at a given place over longer periods of time (seasons to years). Climate is the primary driver of ecological processes on earth. Climate and weather information provide context for understanding the status or condition of other park resources.

Methods

Since 1944, Organ Pipe Cactus NM has operated a National Oceanic and Atmospheric Administration Cooperative Observer Program (COOP) weather station (ORGAN PIPE CACTUS NM, #026132; see Figure 1). This station typically provides a reliable climate dataset. However, in WY2021, the COOP station was missing data on 65 days. As a substitute, climate analyses in this year's report use gridded surface meteorological (GRIDMET) data from the location of the COOP stations, and 30-year averages (1991–2020). Subsequent reports may revert to the weather station as the data source, depending on future data quality.

GRIDMET is a spatial climate dataset at a 4-kilometer resolution that is interpolated using weather-station data, topography, and other observational and modeled land-surface data. Temperature and precipitation estimated from GRIDMET may vary from actual weather at a particular location, depending on the availability of weather-station data and the difference between elevation at the location and that assigned to a grid cell. Data from both the Organ Pipe Cactus NM weather station and GRIDMET are accessible through **Climate Analyzer**.

Recent findings

Precipitation

Annual precipitation at Organ Pipe Cactus NM in WY2021 was 11.80" (30.0 cm; Figure 2)—3.08" (7.8 cm) higher than the 1991–2020 annual average. This surplus primarily occurred in July and August, when the monument received 7.05" (17.9 cm) combined. January, June, July, and August each saw more than double the monthly precipitation of the 1991–2020 monthly averages. Precipitation during the rest of the year was much less than the 1991–2020 monthly averages.

Air temperature

The mean annual maximum air temperature at Organ Pipe Cactus NM in WY2021 was 87.2°F (30.7°C), 0.4°F (0.2°C) warmer than the average annual maximum for 1991–2020. The average annual minimum air temperature in WY2021 was 57.0°F (13.9°C), which was 0.7°F (0.4°C) warmer than the 1991–2020 average minimum. Average monthly maximum and minimum temperatures in WY2021 varied up to 6.9°F (3.8°C) relative to the 1991–2020 average monthly temperatures (Figure 2).

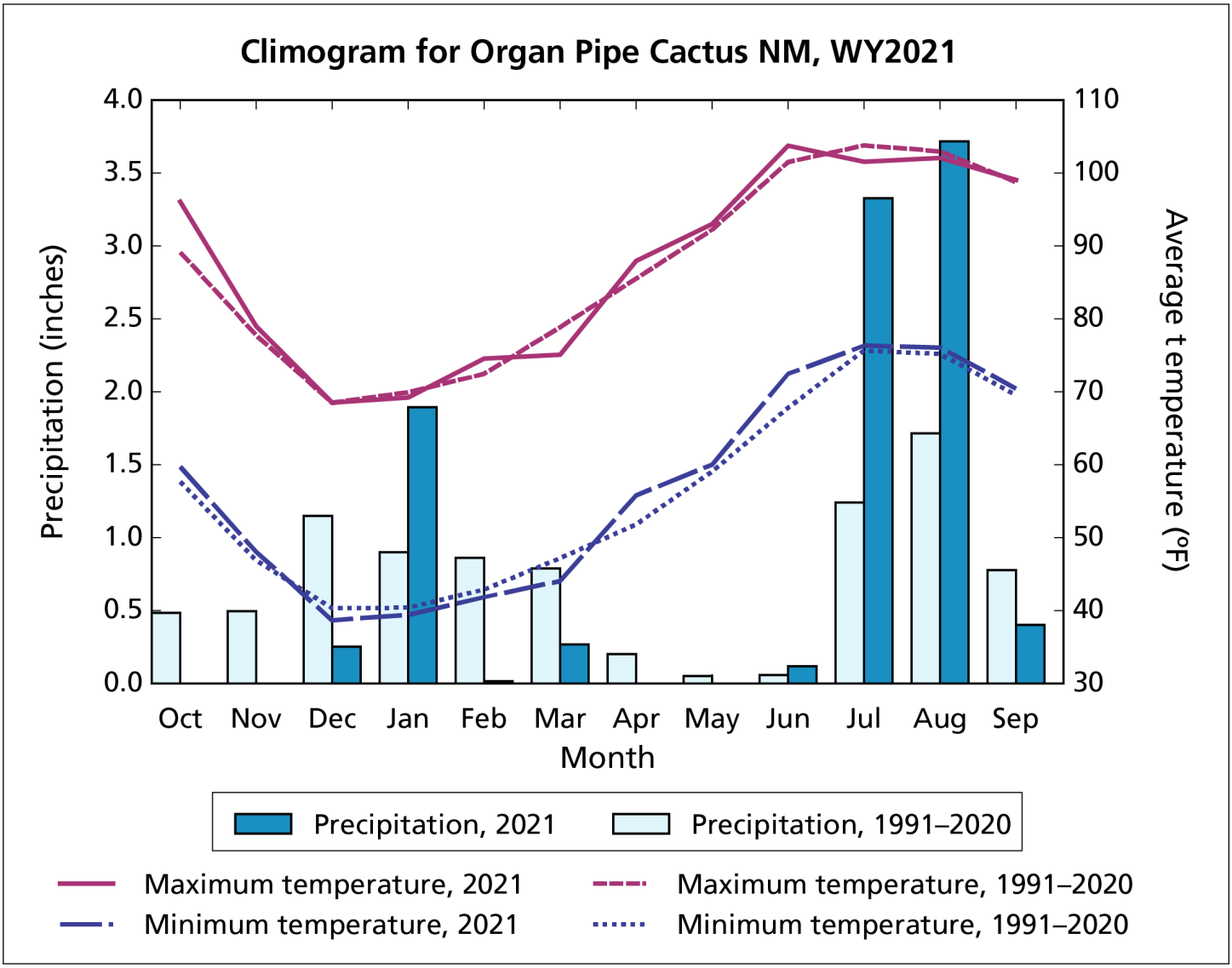


Figure 2. Climogram showing monthly precipitation and mean maximum and minimum temperature, WY2021 and the 1991–2020 means at Organ Pipe Cactus National Monument. Data source: GRIDMET via climateanalyzer.org.

Drought

Reconnaissance drought index (**Tsakiris and Vangelis 2005**) provides a measure of drought severity and extent relative to the long-term climate. It is based on the ratio of average precipitation to average potential evapotranspiration (the amount of water loss that would occur from evaporation and plant transpiration if the water supply was unlimited) over short periods of time (seasons to years). The reconnaissance drought index for Organ Pipe Cactus NM indicates that WY2021 was slightly wetter than the 1991–2020 average, from the perspective of both precipitation and potential evapotranspiration (Figure 3).

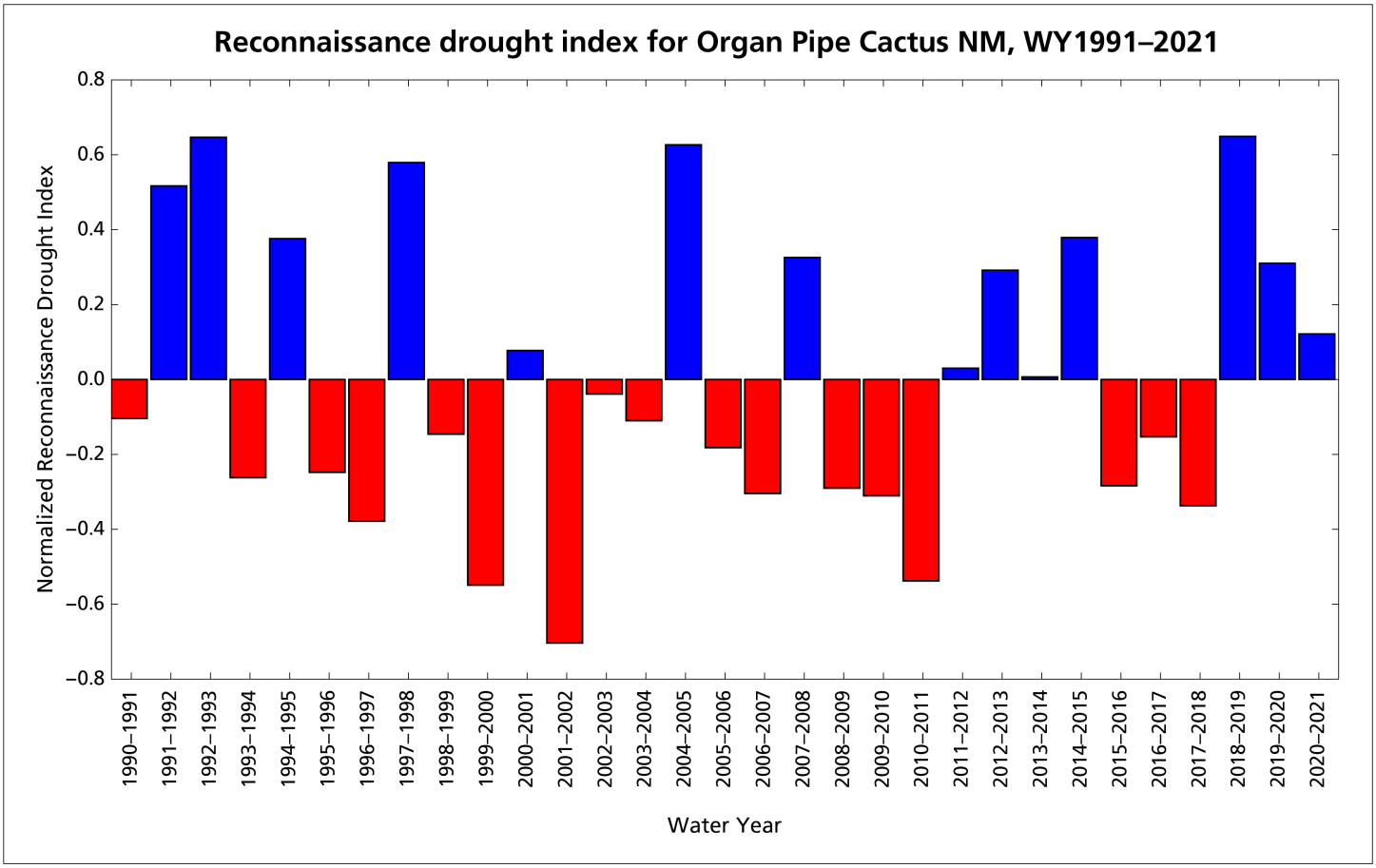


Figure 3. Reconnaissance drought index for Organ Pipe Cactus National Monument, WY1991–2021. Data source: GRIDMET. Drought index calculations are relative to the time period selected (1990–2021). Choosing a different set of start/end points may produce different results.

Climate | **Groundwater** | **Springs**

Groundwater

Groundwater is one of the most critical natural resources of the American Southwest. It provides water for drinking, irrigating crops, and sustaining rivers, streams, and springs throughout the region.

Methods

At Organ Pipe Cactus NM, groundwater is monitored using eight wells (Figure 1). Seven wells are typically monitored quarterly by park staff: Bates, Bonita, Corner, Stack, USGS #1, USGS #2, and USGS #3. The Arizona Department of Water Resources (ADWR) annually monitors an eighth well, Headquarters #5. In

WY2020, continuous monitoring began at four wells: Bates, Headquarters #5, USGS #2, and USGS #3. ADWR data are available from the **ADWR Well Registry Search**.

Recent Findings

Some quarterly measurements were not collected in WY2020 or WY2021 due to covid-19 disruptions to fieldwork. Average groundwater levels in five wells decreased between WY2020 and WY2021 (Figure 1, Table 1). The other three wells were missing data in either WY2020 or WY2021. Headquarters #5, Stack, USGS #1, and USGS #2 have shown similar rates of decline over the monitoring record, likely due to groundwater pumping south of the US–Mexico border. While the depth-to-water at Headquarters #5 is much deeper than the other wells, its water-level elevation is slightly higher, indicating it is upgradient but within the same aquifer. Groundwater levels in Corner well have also been declining, but much more gradually. Groundwater levels in Bates #2, Bonita, and USGS #3 have been more variable over the monitoring record, indicating that these wells are less impacted by recent groundwater pumping.

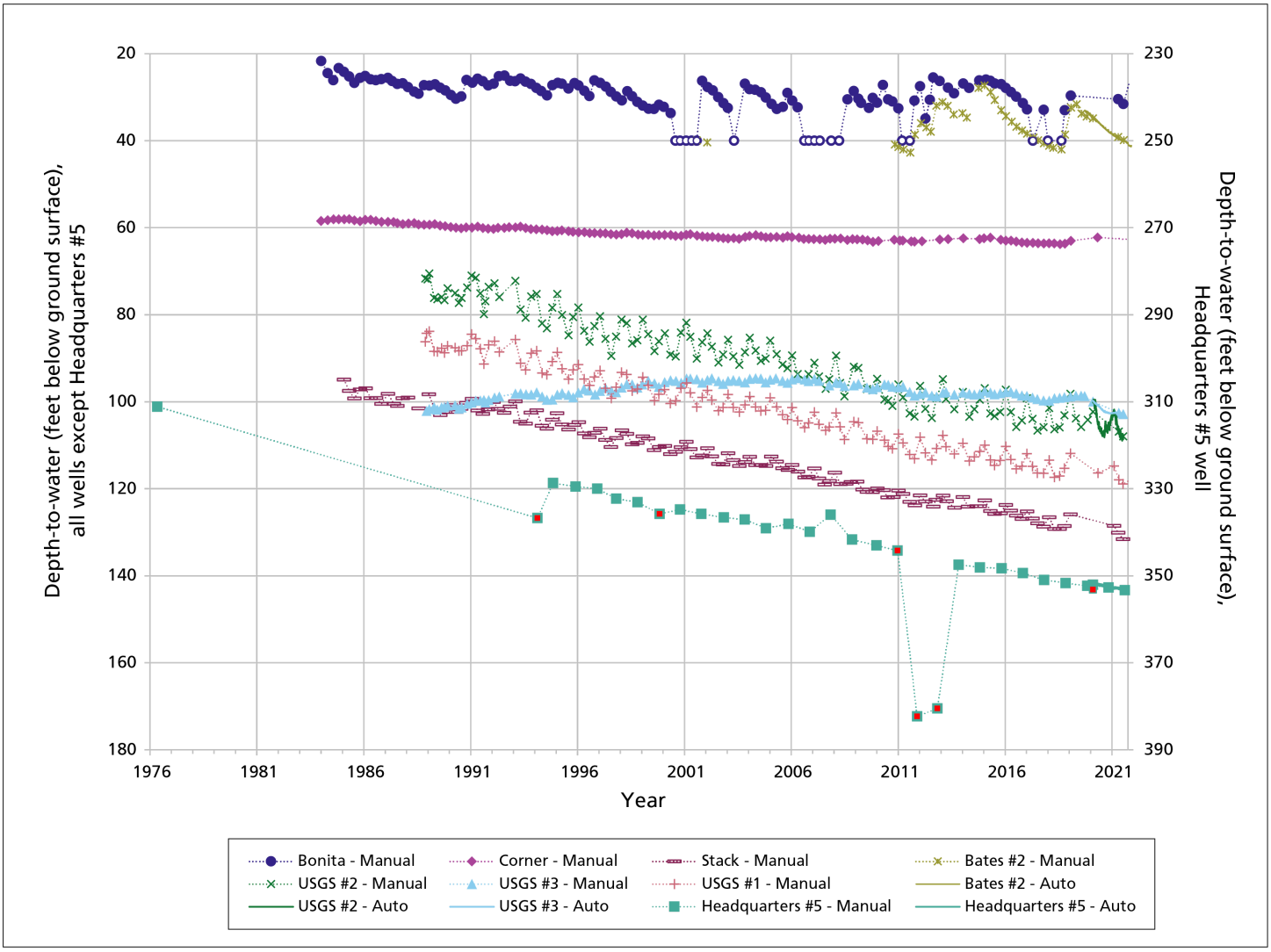


Figure 1. Depth-to-water (feet below ground surface) at eight groundwater monitoring wells at Organ Pipe Cactus National Monument, 1963–2021. Depth-to-water for Headquarters #5 is shown on the right axis. Depth-to-water for all other wells is shown on the left axis. Measurements taken while groundwater pumping occurred are indicated in red. White indicates the well was dry.

Data Table: Groundwater Monitoring Results

Table 1. Groundwater monitoring results for water year 2021, Organ Pipe Cactus National Monument (amsl = above mean sea level; bgs = below ground surface, n/a = not applicable).

Well name	State well number	Wellhead elevation (est. Feet amsl)	Average depth to water (feet bgs) (# of manual measurements)	Average water level elevation (amsl feet)	Change from water year 2020 (± feet)	Change from earliest recorded water level (± feet)
Bates #2 (Bates East)	632186	1,350.00	39.48 (2)	1,310.52	−4.60	−0.47 (2001)
Bonita	629153	1,355.00	31.00 (2)	1,,324.00	n/a	−9.30 (1984)
Corner	n/a	1,000.00	no data (0)	n/a	n/a	n/a
Headquarters #5 (North)	629090	1,660.00	353.00 (2)	1307.00	−0.35	−41.87 (1976)
Stack	n/a	1,405.00	130.06 (3)	1,274.94	n/a	−35.14 (1985
USGS #1 (Camino Dos Republicas)	522034	1,400.00	117.19 (3)	1,282.81	−0.79	−30.99 (1988)
USGS #2 (Lukeville)	522035	1,390.00	107.41 (2)	1,282.59	−4.19	−35.71 (1988)
USGS #3 (Salsola)	522033	1,466.50	102.68 (2)	1,363.82	−2.74	−0.58 (1988)

Climate | **Groundwater** | **Springs**

Springs

Background

Springs, seeps, and tinajas (small pools in a rock basin or impoundments in bedrock) are small, relatively rare biodiversity hotspots in arid lands. They are the primary connection between groundwater and surface water and are important water sources for plants and animals. For springs, the most important questions we ask are about persistence (How long was there water in the spring this year?) and water quantity (How much water was in the spring?).

Methods

Sonoran Desert Network springs monitoring is organized into four modules, described below.

Site characterization

This module includes recording GPS locations and drawing a site diagram and provides context for interpreting change in the other modules. We also describe the spring type (e.g., heleocrene, limnocrene, rheocrene, or tinaja) and its associated vegetation. Helocrene springs emerge as low-gradient wetlands, limnocrene springs emerge as pools, and rheocrene springs emerge as flowing streams. This module is completed once every five years or after significant events.

Site condition

We estimate natural and anthropogenic disturbances and the level of stress on vegetation and soils on a scale of 1–4, where 1 = undisturbed, 2 = slightly disturbed, 3 = moderately disturbed, and 4 = highly disturbed. Types of natural disturbances can include flooding, drying, fire, wildlife impacts, windthrow of trees and shrubs, beaver activity, and insect infestations. Anthropogenic disturbances can include roads and off-highway vehicle trails, hiking trails, livestock and feral animal impacts, removal of invasive non-native plants, flow modification, and evidence of human use. We take repeat photographs that show the spring and its landscape context. We note the presence of certain obligate wetland plants (plants that almost always occur only in wetlands), facultative wetland plants (plants that usually occur in wetlands, but also occur in other habitats), non-native bullfrogs and native crayfish, and we record the density of invasive, non-native plants.

Water quantity

We measure the persistence of surface water, amount of spring discharge, and wetted extent. To estimate persistence, we analyze the variance of temperature measurements taken by logging thermometers placed at or near the orifice (spring opening) or in a tinaja. Because water mediates variation in diurnal temperatures, data from a submerged sensor will show less daily variation than data from an exposed open-air sensor. This tells us when the spring was wet or dry. Surface discharge is measured with a timed sample of water volume. Wetted extent is a systematic measurement of the physical length (up to 100 m), width, and depth of surface water. It is assessed using a technique for either standing water (e.g., limnocrene and heleocrene springs and some tinajas; in the largest pool) or flowing water (e.g., rheocrene springs and some tinajas).

Water quality

We measure core water quality parameters and water chemistry. Core parameters include water temperature, pH, specific conductivity (a measure of dissolved compounds and contaminants), dissolved oxygen (how much oxygen is present in the water), and total dissolved solids (an indicator of potentially undesirable compounds). Discrete samples of these parameters are collected with a multiparameter meter. If the meter fails calibration check(s), we do not present data. Water chemistry is assessed by collecting surface water sample(s) and estimating the concentration of major ions with a photometer in the field. These parameters are collected at one or more sampling locations within a spring, but here we present information only from the primary sampling location. Each perennial spring is somewhat unique, and there are not water quality standards specific to most perennial springs in Arizona or New Mexico. Where conditions exceed water quality standards for other surface waters (rivers, streams, lakes, and reservoirs), we note it, but the reader is advised that these standards were not developed for perennial springs. Our ongoing data collection at each spring will improve our understanding of the natural range in water quality and chemistry parameters for a given site.

Recent Findings

Dripping Springs | **East Arroyo Spring** | **Quitobaquito Spring** | **Snake Pit Tinaja**

Dripping Springs

Dripping Springs (Figure 1, left) was described in WY2017 as a limnocrene spring (emerges as one or more still pools) fed by numerous groundwater seeps along the bedrock walls of a cave located at the base of a cliff face (Figure 1, right). In WY2017, a small seep adjacent to the pool was present and a damp section of the trail extending about four meters from the cave suggested that the pool occasionally flowed over the lip of the cave opening.



Figure 1. *Left:* Dripping Springs with cliff-face seeps. *Right:* Main pool of Dripping Springs, located near a cave at the base of a cliff. NPS photos from March 2021.

Site condition. In WY2021, Dripping Springs was rated as "highly disturbed" for hiking trails and evidence of human use due to impacts from hikers using the Dripping Springs Mine Trail. These ratings were increases from the "slightly" to "moderately" disturbed ratings in the past. There was evidence of trampling and tracks through the springbrook and to the cave entrance. The crew rated Dripping Springs as "undisturbed" for all other categories of human and natural disturbance.

The crew did not observe crayfish or bullfrogs (non-native, potentially invasive aquatic animals) in 2021. However, we did observe two non-native plant genera: hedgemustard (*Sisymbrium* sp.) and dandelion (*Taraxacum* sp.), both at low densities (1–5 plants each). Both invasive plant genera were also observed at similar densities in 2019.

We observed one native facultative wetland plant genus: monkeyflower (*Mimulus* sp.), which has been present since sampling began in 2017.

Water quantity. The WY2021 sampling visit occurred on March 22, 2021. The spring contained water at that time. Temperature sensors indicated that Dripping Springs was "wetted" (contained water) for 123 of 123 days (100%) measured in WY2021. However, the sensors did not function all year (Figure 2). In prior water years, the spring was wetted 100% of the days measured.

The crew was unable to estimate spring discharge, as the outflow was too shallow for measurement. Discharge has not been measured for this reason at

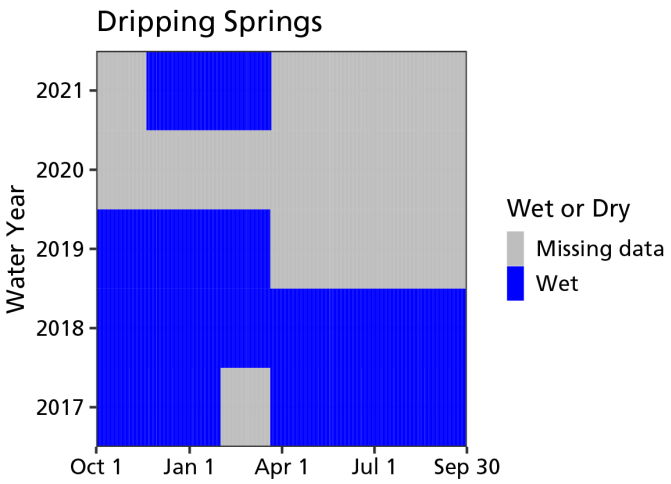


Figure 2. Water persistence at Dripping Springs, 2017–2021.

Dripping Springs during the entire monitoring period (WY2017–2021). Wetted extent was evaluated using a method for flowing water. For 2021, the springbrook length, width, and depth were all within the range of prior years (Table 1, below).

Water quality. The crew collected data on core water quality parameters and water chemistry within the pool inside the cave (Tables 2 and 3). The values for all parameters were within the ranges observed during prior years, with two exceptions: (1) chloride was 4 mg/L above any prior observation (with minimum detection level of 0.5 mg/L), but is not considered a concern for wildlife or human health, and (2) sulfate was less than half the previous low observed.

Data Tables for Dripping Springs

Table 1. Average (± SD) width and depth (cm) of Dripping Springs within springbrook length (up to 100 m) in water year 2021, and a range of values from prior years.

Measurement	WY2021	Range of values, WY2018–2019 (# of measurements)
Width (cm)	44.6 ± 28.3	43–56.8 (2)
Depth (cm)	0.1 ± 0	0.1–0.4 (2)
Length (m)	6.8	2.8–8.3 (2)

Table 2. Data on core water quality parameters for Dripping Springs in water year 2021 (primary sampling location only), and a range of values from prior years.

Sampling location	Width/Depth	Parameter	WY2021	Range of values, WY2017–2019 (# of measurements)
001	Center	Dissolved oxygen (mg/L)	1.38	0.83–1.68 (3)
001	Center	pH	7.46	7–7.49 (3)
001	Center	Specific conductivity (µS/cm)	380.2	306.5–407.8 (3)
001	Center	Temperature (°C)	12.7	12.9–16.1 (4)
001	Center	Total dissolved solids (mg/L)	247	198.9–265.2 (3)

Table 3. Water chemistry data (mg/L) for Dripping Springs in water year 2021, and a range of values from prior years. bdl = below detection limits.

Sampling location	Width/Depth	Parameter	WY2021	Range of values, WY2017–2019 (# of measurements)
001	Center	Alkalinity ($CaCO_3$)	165	70–125 (3)
001	Center	Calcium (Ca)	2	2 (3)
001	Center	Chloride (Cl)	13	4–9 (3)
001	Center	Magnesium (Mg)	1	bdl–5 (3)
001	Center	Potassium (K)	7	3.6–19 (3)
001	Center	Sulphate (SO_4)	7	18–31 (3)

Climate | **Groundwater** | **Springs** |
Dripping Springs | **East Arroyo Spring** | **Quitobaquito Spring** | **Snake Pit Tinaja**

East Arroyo Spring

East Arroyo Spring (Figure 3, left) was described in WY2018 as a large, persistent tinaja (pool in a rock basin) that lies at the base of a 10-meter bedrock cliff within a large drainage below Ajo Peak (Figure 3, right).



Figure 3. East Arroyo Spring (left), is located in a narrow canyon below steep cliffs (right; spring is at bottom center). NPS photos from March 2021.

Site condition. In WY2021, East Arroyo Spring was rated as “slightly disturbed” for recent flooding due to evidence of recent flooding in the channel. We also observed slight impacts from flooding in 2019, suggesting the channel is occasionally subject to substantial overland flow from storm runoff. The crew rated East Arroyo Spring as “undisturbed” for all other categories of human and natural disturbance.

The crew did not observe crayfish or bullfrogs (non-native, potentially invasive aquatic animals) or any non-native plants during surveys in 2021. As in past years, we did observe the facultative wetland plant genus *Mimulus* (monkeyflower).

Water quantity. The WY2021 visit occurred on March 24, 2021. The spring contained water. Temperature sensors indicated that East Arroyo Spring was “wetted” (contained water) for 122 of 122 days (100%) in WY2021, but sensors were not operational at the start of the water year. In prior water years, the spring was wetted 56.5–94.9% of the days measured, with an extended dry period in the summer of WY2018, and shorter dry periods in the fall/winter of WY2019 and 2020 and mid-summer of WY2017 (Figure 4).

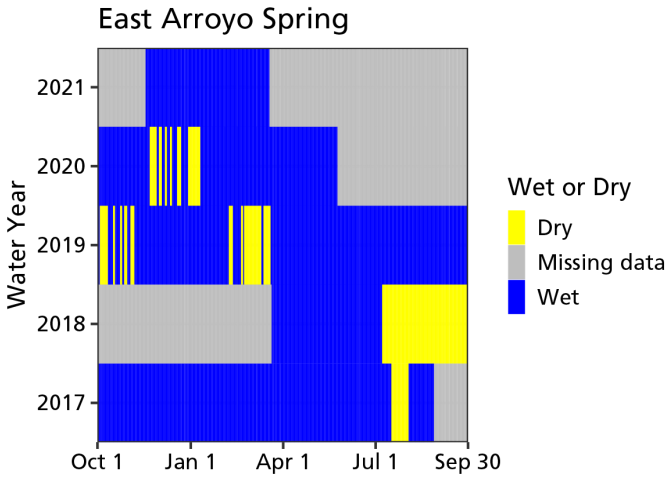


Figure 4. Water persistence at East Arroyo Spring, 2017–2021.

We were unable to estimate spring discharge, as the outflow was too shallow for measurement. During the last sampling of East Arroyo Spring (WY2019), discharge was estimated at 19.2 L/min (Table 4, below). Wetted extent was also not evaluated in WY2021, as the tinaja’s steep sides prevented safe access for measuring pool dimensions.

Water quality. The crew collected data on core water quality parameters and water chemistry within the downstream edge of the pool (Tables 5 and 6). Most values were within the range of prior years, with some notable exceptions: (1) at 9.32, pH was considerably more basic than in prior sampling, (2) dissolved oxygen was slightly higher (~2.8 mg/L) than the previous high value, and (3) chloride was nearly twice as high (+20 mg/L with minimum detection level of 0.5 mg/L) as the previous maximum value, but is not considered a concern for wildlife or human health. While there are no water quality standards specific to East Arroyo or most other springs in Sonoran Desert parks, pH in WY2021 exceeded the Arizona water quality standard of pH (6.5–9.0) for three designated uses for other surface waters (rivers, streams, lakes, and reservoirs): full- and partial- body contact (humans), and aquatic and wildlife.

Data Tables for East Arroyo Spring

Table 4. Discharge data (L/min; mean ± SD) for Quitobaquito Spring in water year 2021 (primary sampling location only), and a range of values from prior years. CNS=could not sample.

Sampling Location	WY2021	Previous value, WY2019 (# of measurements)
001	CNS	19.2 (1)

Table 5. Data on core water quality parameters for East Arroyo Spring in water year 2021 (primary sampling location only), and a range of values from prior years.

Sampling Location	Width/Depth	Parameter	WY2021	Range of values, WY2018–2019 (# of measurements)
001	Center	Dissolved oxygen (mg/L)	13.15	9.35–10.28 (2)
001	Center	pH	9.32	7.92–8.43 (2)
001	Center	Specific conductivity (µS/cm)	210	179.5–283.5 (2)
001	Center	Temperature (°C)	11.4	12.8–13.4 (3)
001	Center	Total dissolved solids (mg/L)	137	116.3–184.6 (2)

Table 6. Water chemistry data (mg/L) for East Arroyo Spring in water year 2021, and a range of values from prior years

Sampling Location	Width/Depth	Parameter	WY2021	Range of values, WY2018–2019 (# of measurements)
001	Center	Alkalinity ($CaCO_3$)	55	35–90 (2)
001	Center	Calcium (Ca)	16	14–22 (2)
001	Center	Chloride (Cl)	42	10–22 (2)
001	Center	Magnesium (Mg)	6	5–9 (2)
001	Center	Potassium (K)	3.6	2.8–4.1 (2)
001	Center	Sulphate (SO_4)	4	0 (2)

Climate | **Groundwater** | **Springs** |
Dripping Springs | **East Arroyo Spring** | **Quitobaquito Spring** | **Snake Pit Tinaja**

Quitobaquito Spring

Quitobaquito Spring (Figure 5) was first described in 2017 as a rheocrene spring (emerges as a flowing stream) that emerged at the foot of a low hill as a muddy seep. It then feeds into channel 16 meters long and then into a larger pool and weir (discharge monitoring instrument modifying the channel; Figure 6, left). Beyond that, the springbrook flows more than 200 meters through a concrete channel (Figure 6, right) that supports Quitobaquito Pond.



Figure 5. Quitobaquito Spring in March 2021. NPS photo.



Figure 6. Left: An unlined springbrook flows from Quitobaquito Spring to a weir. Right: A cement-lined springbrook flows from below the weir to Quitobaquito Pond. NPS photos from March 2021.

Site condition. Visitor access and site development contribute to a number of impacts at this spring. Flow is heavily modified by installation of a permanent weir and springbox, and the springbrook is cemented to limit infiltration ahead of the outflow to Quitobaquito Pond. Additionally, hiking trails and their maintenance (vegetation clearing) resulted in slight-to-moderate impacts during WY2021 due to vegetation trampling and removal. Wildlife use of the spring was also evident in tracks and trampling. The crew did not observe crayfish or bullfrogs (non-native, potentially invasive aquatic animals), nor did they detect any non-native plants.

The crew observed the facultative wetland plant, mulefat (*Baccharis salicifolia*), and several obligate plant genera or families: bulrush (*Schoenoplectus* sp.), cattail family (Typhaceae), rush family (Juncaceae), sedge family (Cyperaceae), and spikerush (*Eleocharis* sp.). Each of these wetland plants has been detected in one or more prior years of sampling at Quitobaquito Spring.

Water quantity. The WY2021 visit occurred on March 25, 2021. The spring contained water. Temperature sensors indicated that Quitobaquito Spring was "wetted" (contained water) for 127 of 127 days (100%) measured up to the WY2021 visit. However, data were not available for the start of WY2021. In prior water years, the spring was wetted 100% of the days measured (Figure 7).

Discharge (Table 7, below) was estimated at 35 (± 1.3) liters (9.3 ± 0.3 gal) per minute in WY2021, within the range observed in past years.

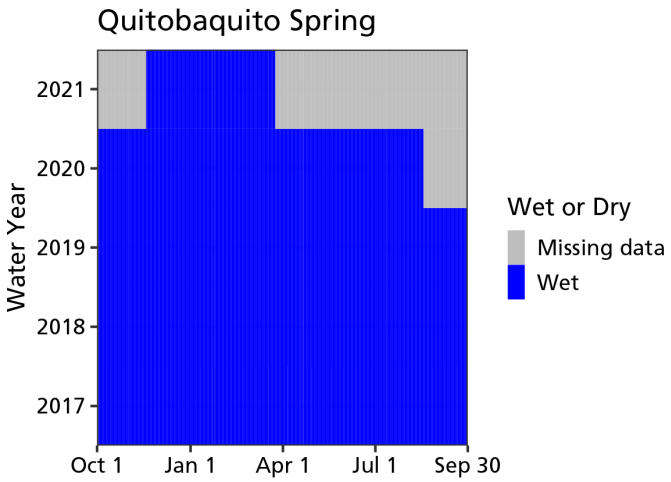


Figure 7. Water persistence at Quitobaquito Spring, 2017–2021.

Wetted extent was evaluated using a method for flowing water (Table 8). The total brook length was estimated at 200–500 meters and, as in all previous years, flowed into Quitobaquito Pond. Width and depth averaged 37.9 centimeters and 9.4 centimeters, respectively, within the first 100 meters. Length, width, and depth values were within the ranges observed in past years.

Water quality. The crew collected data on core water quality parameters and water chemistry at a pool just upstream of the weir (Tables 9 and 10). Dissolved oxygen, pH, and most chemical parameters were slightly above the range of values observed in past years. Potassium and magnesium were comparable with past values. Water temperature, specific conductivity, and total dissolved solids were slightly below any values observed at Quitobaquito Spring in the past. All observed values were well within **Arizona water quality standards**.

Data Tables for Quitobaquito Spring

Table 7. Discharge data (L/min; mean ± SD) for Quitobaquito Spring in water year 2021 (primary sampling location only), and a range of values from prior years.

Sampling Location	WY2021	Range of values, WY2018–2019 (# of measurements)
003	35 ± 1.3	33–44.1 (2)

Table 8. Average (± SD) width and depth (cm) of Quitobaquito Spring within springbrook length (up to 100 m) in water year 2021, and a range of values from prior years.

Measurement	WY2021	Range of values, WY2017–2019 (# of measurements)
Width (cm)	37.9 ± 38.6	31–53.6 (3)
Depth (cm)	9.4 ± 8.7	4.2–12.9 (3)
Length (m)	100	100 (3)

Table 9. Data on core water quality parameters for Quitobaquito Spring in water year 2021 (primary sampling location only), and a range of values from prior years.

Sampling location	Width/Depth	Parameter	WY2021	Range of values, WY2017–2019 (# of measurements)
002	Center	Dissolved oxygen (mg/L)	8.24	6.6–7.32 (2)
002	Center	pH	7.75	7.59–7.62 (2)
002	Center	Specific conductivity (µS/cm)	1,125	1,177–1,181 (2)
002	Center	Temperature (°C)	23.7	25.1–26.6 (3)
002	Center	Total dissolved solids (mg/L)	731	767 (2)

Table 10. Water chemistry data (mg/L) for Quitobaquito Spring in water year 2021, and a range of values from prior years.

Sampling location	Width/Depth	Parameter	WY2021	Range of values, WY2017–2019 (# of measurements)
002	Center	Alkalinity ($CaCO_3$)	285	240–250 (2)
002	Center	Calcium (Ca)	34	22–28 (2)
002	Center	Chloride (Cl)	175	110–150 (2)
002	Center	Magnesium (Mg)	17	13–17 (2)
002	Center	Potassium (K)	4.3	4.4–4.7 (2)
002	Center	Sulphate(SO_4)	104	77–85 (2)

Climate | **Groundwater** | **Springs** |
Dripping Springs | **East Arroyo Spring** | **Quitobaquito Spring** | **Snake Pit Tinaja**

Snake Pit Tinaja

Snake Pit Tinaja (Figure 8, left) was described in 2017 as an isolated, bathtub-sized tinaja (small pool in rock basin) in the middle of a wide canyon in the north fork of Alamo Canyon (Figure 8, right). It is located within a wide expanse of bedrock and appears to be primarily fed by overland flow.



Figure 8. Snake Pit Tinaja (left) is an isolated pool in Alamo Canyon (right). NPS photos from March 2021.

Site condition. Snake Pit Tinaja was rated as “slightly disturbed” for evidence of human use due to trash observed near the spring, as has been observed occasionally at this site in past years. The crew also rated the tinaja as “slightly disturbed” for wildlife impacts for the first time in 2021, as they observed a decaying bird in the tinaja. Snake Pit Tinaja was rated as “undisturbed” for all other human and natural disturbances.

The crew did not observe crayfish or bullfrogs (non-native and potentially invasive aquatic animals) or non-native plant species in 2021. Obligate or facultative wetland plants were also not observed, likely due to the expanse of bedrock around the spring.

Water quantity. The WY2021 visit occurred on March 23, 2021. The spring contained water. Temperature sensors indicated that Snake Pit Tinaja was “wetted” (contained water) for 125 of 125 days (100%) measured

up to the WY2021 visit, with some data missing early in the water year. In prior water years, the spring was wetted 84.8–99.5% of the days measured (Figure 9).

There was no discharge from Snake Pit Tinaja at the time of sampling. Wetted extent was evaluated using a method for standing water (Table 11, below). Width averaged 99.7 centimeters. Length averaged 218.5 centimeters, and depth averaged 65.5 centimeters—all within the ranges measured in prior years.

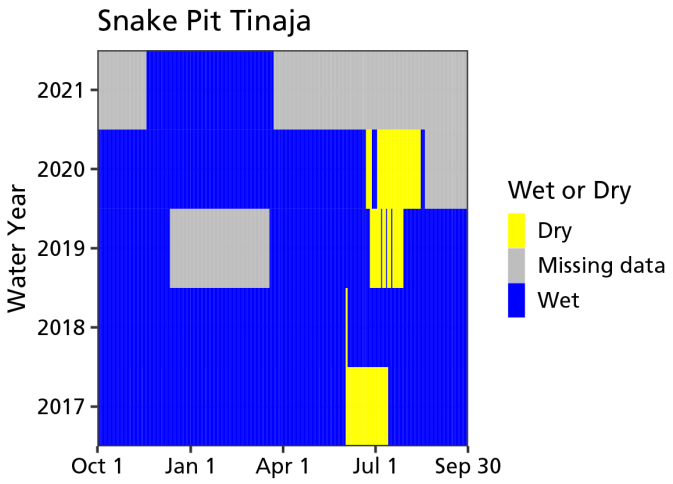


Figure 9. Water persistence at Snake Pit Tinaja, 2017–2021.

Water quality. The crew collected data on core water quality parameters and water chemistry within Snake Pit Tinaja along the downstream edge of the pool (Tables 12 and 13). All parameters were within the ranges observed in past years at this location, except for water temperature, which was about 2°C colder than the previously observed low temperature. While there are no water quality standards specific to Snake Pit Tinaja or most other springs in Arizona, pH in WY2021 and some previous years exceeded the Arizona water quality standard of pH (6.5–9.0) for three designated uses for other surface waters (rivers, streams, lakes, and reservoirs): full- and partial- body contact (humans), and aquatic and wildlife.

Data Tables for Snake Pit Tinaja

Table 11. Average (± SD) width, length, and depth (cm) of Snake Pit Tinaja in water year 2021, and a range of values from prior years.

Measurement	WY2021	Range of values, WY2018–2019 (# of measurements)
Width (cm)	99.7 ± 9.3	41.2–108.8 (2)
Depth (cm)	65.5 ± 6.3	14.5–67.3 (2)
Length (cm)	218.5 ± 13.9	65–241.7 (2)

Table 12. Data on core water quality parameters for Snake Pit Tinaja in water year 2021 (primary sampling location only), and a range of values from prior years.

Sampling location	Width/Depth	Parameter	WY2021	Range of values, WY2017–2019 (# of measurements)

001	Center	Dissolved oxygen (mg/L)	12.71	2.97–13.56 (3)
001	Center	pH	9.56	7.55–9.67 (3)
001	Center	Specific conductivity (µS/cm)	296.9	264–1,045 (3)
001	Center	Temperature (°C)	9.8	11.9–15.2 (4)
001	Center	Total dissolved solids (mg/L)	193	165.1–676 (3)

Table 13. Water chemistry data (mg/L) for Snake Pit Tinaja in water year 2021, and a range of values from prior years. bdl = below detection limits.

Sampling location	Width/Depth	Parameter	WY2021	Range of values, WY2017–2019 (# of measurements)
001	Center	Alkalinity ($CaCO_3$)	140	55–470 (3)
001	Center	Calcium (Ca)	48	8–74 (3)
001	Center	Chloride (Cl)	bdl	bdl–29 (3)
001	Center	Magnesium (Mg)	bdl	bdl–7 (3)
001	Center	Potassium (K)	7.5	3.6–9.5 (3)
001	Center	Sulphate (SO_4)	8	0–9 (3)

Past Findings

Climate and Water Monitoring at Organ Pipe Cactus National Monument, Water Year 2018

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