Water Quality

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Objectives: Long term trends in water quality vital signs at tinajas and perennial springs, long term trends in flow rate at Quitobaquito springs system.

Introduction

Perennial water bodies are scarce in arid to semi-arid central and southern Arizona. The presence of water and riparian habitats around surface waters create biological focal points for the surrounding region. The chemical and biological integrity of these waters is critical to the vitality and continued existence of aquatic and upland ecosystems. Ensuring the integrity of park water quality, due to its importance in sustaining natural, aquatic park ecosystems is a fundamental component of the NPS's mission.The goal of the water quality monitoring program at Organ Pipe Cactus National Monument (OPCNM) is to provide data on water quality and quantity to better understand the natural variation in surface water systems.

Water quality management objectives will meet all state (ADEQ 2003) and federal (EPA) requirements. Director's Order #83 and outlines additional water quality standards for National Parks (1999). Park specific natural resource management goals are outlined in the Draft General Management Plan – Development Concept Plan – Environmental Impact Statement (OPCNM 1995 draft). These include:

1. Protection of the natural and cultural resources of Quitobaquito Springs area, while accommodating visitor use.
2. Establish and maintain baseline data on the condition of Sonoran Desert ecosystems.
3. Achieve sufficient understanding of Sonoran Desert ecosystems for effective protection.
4. Restore and preserve intact a significant and representative portion of Sonoran Desert ecosystems.
5. Protection of critical habitat at Quitobaquito Springs for the Quitobaquito desert pupfish.

The monument exhibits topography typical of the basin and range province, consisting of valleys filled with alluvium eroded from the surrounded mountain ranges. Elevation in the monument ranges from 300m to 1465m. Average annual rainfall at OPCNM was 9.5 in/yr at an elevation of 512m (Western Regional Climate Center, 2004). Sources of surface water are very limited. No perennial rivers or streams exist within the monument; ephemeral flow occurs for brief periods as a result of locally heavy summer raimstorms or rare regional storms. Brown et al (1983) inventoried surface water resources at the monument and provided information for three springs, 68 tinajas (rainfall recharged ephemeral and intermittent bedrock catchments), three stock tanks, seven watering troughs, and three sewage disposal ponds. The watering troughs and stock tanks were eliminated as water sources by the monument in 1982. The perennial springs provide the only reliable year-round water source and are extremely important to biota and wildlife.

Springs

Quitobaquito is an aquifer-fed wetland located in the southwest corner of the monument on the U.S./Mexico border. The permanent waters in this area have been a focal point of human migration and occupation for thousands of years, and the complicated cultural/natural interactions persist to this day. The NPS acquired the wetland from the last Hia'ced O'odham inhabitant in 1958, and since then has faced the difficulty of managing a human-manipulated landscape as a natural preserve, which is the principal remaining habitat for the Desert Pupfish (*Cyprinodon eremus*). The springs, channel, seeps and pond form a system that dates to the 1800s, and are designated critical habitat for the Desert

Pupfish. The Quitobaquito system also supports the endemic Quitobaquito tryonia snail (*Tryonia quitobaquitae*), an isolated population of Sonoran mud turtle (*Kinosternon sonoriensis*) (candidate for federal listing), a diverse resident and migrant avian fauna, foraging free-tailed bat species, and medicinal wetland plants.

Dripping Springs is another important perennial spring within the park, especially for wildlife water. In the driest periods, it may be the only source of water in 270 square miles (700km^2.) It is formed by a fracture seep in a small cave. The flow is contained within the cave and a small catchment basin (Brown et al 1983). The water levels have been declining for the last three years, possibly from the continuing drought. Dripping Springs is along a major illegal trafficking route and water quality is being impacted by trash and fecal material from these activities.

Tinajas

Tinajas (or rock pools) are important ecological systems due to their relative scarcity and critical functions for terrestrial wildlife and unique plant communities. Rock pools in arid systems have received scant attention in the scientific literature, yet they may be the most susceptible of all aquatic habitats to human influences (Dodson 1988). There are approximately 68 major tinajas in the monument. Most are in the Ajo (35), Bates (15), and Puerto Blanco (8) Mountains (Brown et al 1983). The longevity of the water is affected by the size and runoff characteristics of the watershed draining into the tinaja, volume of the catchments, amount of shade received, and permeability of the bedrock. Water quality of tinajas is highly variable, and is susceptible to contamination from human activities and atmospheric deposition of chemicals.

Water quality

The National Park Service (NPS) Water Resources Division (WRD) have identified three water-quality parameters and two physical parameters as "core" freshwater indicators for long-term aquatic monitoring projects (NPS 2002). These measures were selected as the most fundamental parameters required for characterization of water-quality of aquatic ecosystems, and are known to be related to both biological and physicochemical processes. The required measures include:

- Specific conductance
- Dissolved oxygen
- pH
- Temperature
- Flow rate or water level

Surface water chemistry measurements and Quitobaquito temperature monitoring were started in 1998 after funding from the U.S. Air Force Quitobaquito Wetlands Project allowed purchase of water monitoring equipment. Instrumentation and protocol were modeled after a pilot study at Joshua Tree National Park.

Water quantity

The two primary springs in the Quitobaquito system have been historically managed to provide water to the pond. In 1974 a V-notch weir flow was installed to facilitate spring monitoring at Quitobaquito (NPS 1992). U.S. Geological Survey (USGS) personnel began analog recording of discharge stage at the weir in 1981. In 1990 a 2-inch Parshall flume and a dry datalogger bunker were installed as part of the Quitobaquito Habitat Project. This flume continues to be the primary monitoring point for spring discharge at the site. Digital monitoring using a pressure transducer and datalogger was conducted by USGS 1990-1992. Flow rates reported by Carruth (1996) indicate a range between 15 and 40 gallons per minute (gpm) (57 and 151 liters per minute) with an average of 28 gpm (106 liters per minute) between 1981 and 1992. Spring flow and pond level at Quitobaquito have declined in recent years. In 2005, NPS hydrologist Colleen Filippone assisted OPCNM staff with the installation of a new continuous flow monitor at the springs, as well as continuous digital temperature, dissolved oxygen and conductivity monitors.

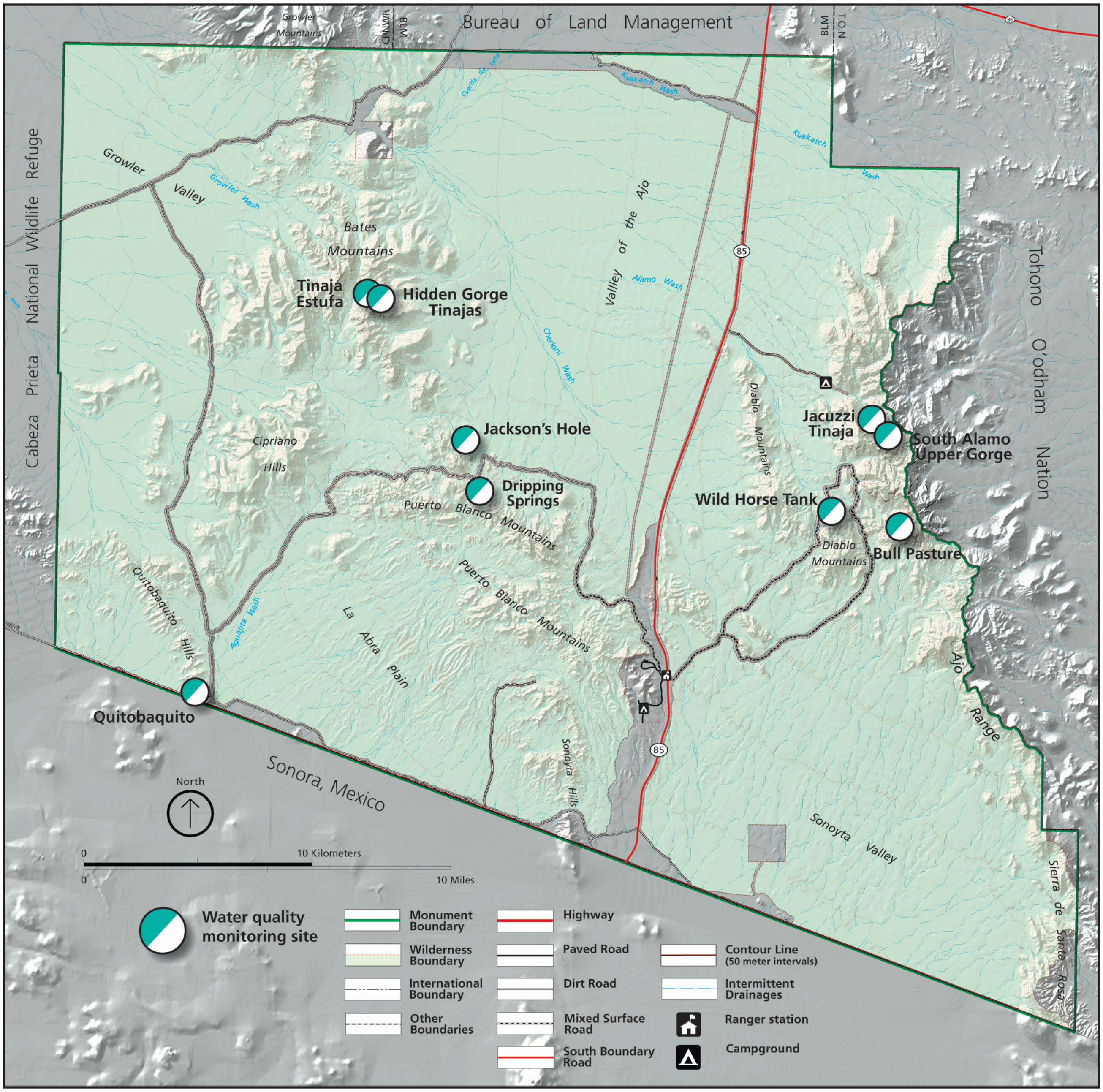

Figure 14-1. Water quality monitoring sites, Organ Pipe Cactus N.M.

Methods

Water chemistry

Selected tinaja sites and Quitobaquito springs, channel and pond were sampled seasonally from 1998 to 2005 (Figure 14-1). The following parameters were measured: specific conductance, dissolved oxygen, pH, and temperature. Air temperature and approximate water level were also recorded most of the time. From 1998 to 2001, alkalinity was also measured.
The same testing equipment was used consistently throughout the project: Orion 115 conductivity meter and cell, Orion 250A pH meter and low maintenance triode pH probe, YSI 95 dissolved oxygen meter and Hach alkalinity titration test kit (Figure 14-2). Temperature was usually taken from the conductivity and pH meters' automatic temperature compensation probes. Various thermometer models were used for air temperature.

The pH meter was calibrated in the office or in the field for each monitoring session, using pH 7 and pH 10 standard buffer solutions. The conductivity meter was calibrated by measuring a 75, 447, or 1413 μs standard solution, depending on the expected value of the sample. This measurement was used to calculate a correction factor for the water sample measurement. The YSI dissolved oxygen meter was calibrated in the field by entering altitude and salinity values.
Measurements for pH and conductivity were taken by submerging the probes approximately 8 cm into the surface water site, and letting the probes equilibrate to water temperature for approximately 1-2 minutes. Values recorded were usually the second or third stable reading, or an average of 3 readings. The YSI dissolved oxygen probe was allowed to equilibrate in the atmosphere for at least 15 minutes. The probe was then submerged 8-10 cm and agitated in the surface water site at the rate of 1 foot per second. After readings stabilized, a measurement was recorded.

Water temperature

Hobo Stowaway temperature sensors were deployed at Quitobaquito intermittently from 1997-2004 at the southwest spring, in mid-channel pools, and in the pond. In November 2005, these sensors were replaced by new Hobo H8 temperature sensors in the channel, moat and pond.

Stowaway temperature sensors were programmed to record hourly temperatures, and placed in

Figure 14-2. Water quality testing equipment in the OPCNM laboratory.

Table 1. Physical characteristics of selected water chemistry monitoring sites, Organ Pipe Cactus N.M. (Description of geologic substrate from Geological Reconnaisance map of Organ Pipe Cactus National Monument.)

Site	Elevation (m)	Estimated volume (g), from Brown 1983	Description of geologic substrate
South Alamo Canyon	820	376	Rhyolite, rhyodacite and minor dacite flows
Jackson's Hole	520	2059	Childs latite flows and flow breccias
Dripping Springs	630	2510	Augite andesite
Tinaja Estufa	580	4996	Childs latite flows and flow breccias
Wild Horse Tank	725	64,241	Rhyolite, rhyodacite and minor dacite flows
Quitobaquito Springs	335	--	Biotite granite of Aguajita Spring

Table 2. Summary of water chemistry results at selected sites, 1998-2005, Organ Pipe Cactus N.M.

Site	pH mean	pH range	conductivity mean (µs)	conductivity range (µs)	dissolved oxygen range (mg/l)
Dripping Springs (excluding July 2001)	7.2	7.03 – 7.40	351	289 – 399	0.2 – 7.7
Dripping Springs, July 15,2001	6.58	--	849	--	0.9
Quitobaquito-southwest spring	7.5	7.43 – 7.67	1164	1112 – 1191	4.83 – 8.3
Quitobaquito-midchannel pool	8.0	7.87 – 8.14	1173	1115 – 1374	5.86 – 9.83
Quitobaquito pond (W shore)	9.3	8.46 – 9.88	1312	1149 – 1552	1.49 – 15.3
South Alamo Canyon (Jacuzzi)	8.5	6.98 – 10.68	287	221 – 344	1.71 – 14.5
Tinaja Estufa	9.5	8.33 – 10.64	273	117 – 451	5.43 – 16.7
Wild Horse Tank	8.9	8.04 – 9.99	282	175 – 401	5.93 – 15.49

submersible cases. They were brought back to the office for data download.

Quitobaquito southwest spring monitoring
In 2005, NPS Intermountain Region hydrologist Filippone and OPCNM staff installed continuous flow monitoring and water chemistry monitoring system consisting of a Campbell Scientific CR21x datalogger, a 0-1 psi pressure transducer, a Campbell Scientific CS547A-L30 water conductivity/temperature probe, and a Oxyguard dissolved oxygen probe. Manual discharge measurements are also made just below the southwest spring; this is accomplished by blocking the channel with towels and diverting water into a 3-inch diameter plastic pipe for collecting time versus discharge measurements. Two observers with stopwatch and measuring

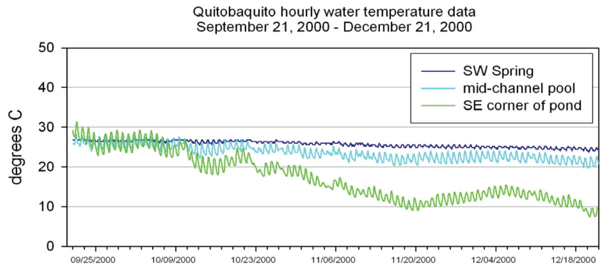

Figure 14-3. Quitobaquito water temperature, September 21-December 21, 2000.

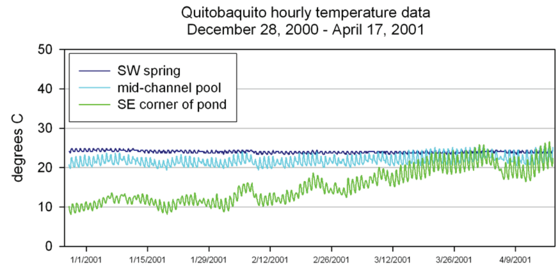

Figure 14-4. Quitobaquito water temperature, December 28-April 17, 2001.

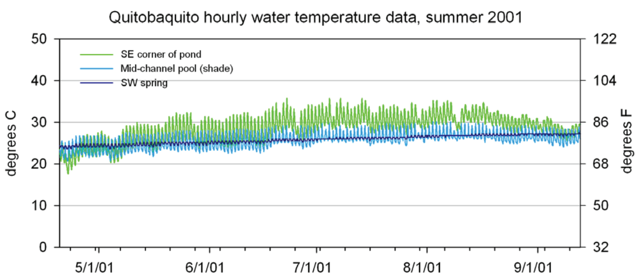

Figure 14-5. Quitobaquito water temperature, April – September, 2001.

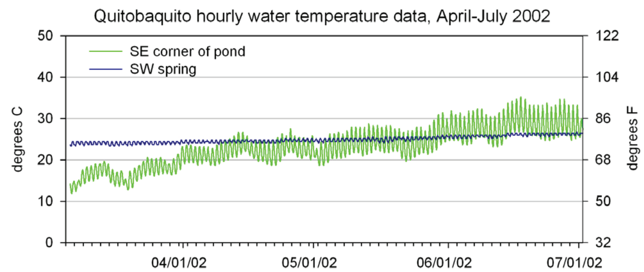

Figure 14-6. Quitobaquito water temperature, April - July 2002.

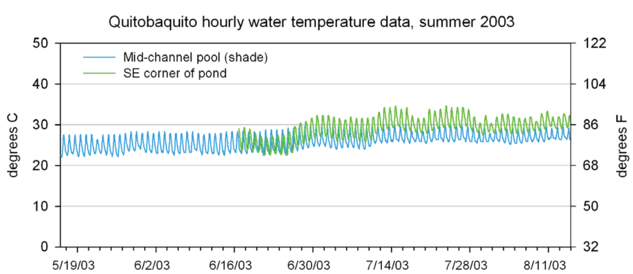

Figure 14-7. Quitobaquito water temperature, May – August 2003.

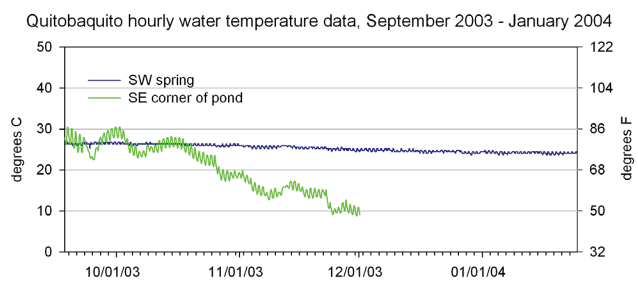

Figure 14-8. Quitobaquito water temperature, September 2003 - January 2004.

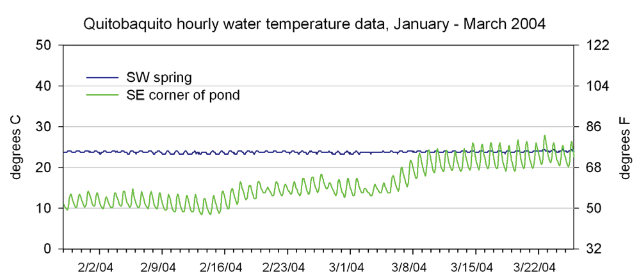

Figure 14-9. Quitobaquito water temperature, January - March 2004, Organ Pipe Cactus N.M.

bucket are required for this process.

Miscellaneous Quitobaquito water quantity observations
In addition to water quantity data monitoring from instrumentation, monument staff have recorded information on flume stage and pond level during routine Quitobaquito inspections since 1991. Pond level is a standardized measurement from the bottom lip of the overflow pipe.

Results

Water chemistry
In initial protocol development, three seasons were identified as important for tinaja sampling: after winter rains, late spring after many tinajas have dried up and water is concentrated at a few important wildlife sites, and after summer monsoon rains. Since monument wet deposition monitoring has shown a clear difference between summer and winter precipitation chemistry, the objective was to see if tinaja chemistry was effected by rainfall events. However, the variability of pH and conductivity over time did not appear to correlate with specific seasons; the geologic substrate (Table 14-1) of the tinajas likely buffers precipitation deposition. Also, tinaja waters are subject to constant changes in recharge rates, temperature and plant growth, all which affect water chemistry.

Quitobaquito demonstrated the least variability in water chemistry results, 1998-2005 (Table 14-2, Tables 14-9 through 14-11). Conductivity and pH measurements were very consistent in the southwest spring pool, the channel and the pond; while dissolved oxygen measurements were fairly consistent in the southwest spring and channel only.

Dripping Springs water chemistry (Table 14-3) changed significantly after an extreme event in summer 2001. Staff found the water level at an all-time low (60 cm below lip of dam), and the water fouled with decaying bees and birds, and illegal migrant trash. Water chemistry was measured before a clean-up effort (15 July 2001) and after the clean-up effort (22 July 2001). A detailed report on Dripping Springs' physical conditions in 2001 and management actions is available in Appendix E.

Water temperature
Water temperature data from 1998-2004 show a consistent diurnal pattern (Figures 14-3 - 14-9), with the southeast pond site fluctuating the most with seasonal temperature change. The southwest spring mean temperature range was 23.9 – 27.1 degrees C, September 2000-February. During that time frame, the southeast pond maximum temperature was 35.8 degrees C on June 22, 2001, and minimum temperature was 6.6 degrees C on December 17, 2001.

Quitobaquito springs
Stage-flow rate measurements to date illustrate typical diurnal cycling attributable to evapotranspiration effects. Perturbations to stage in the data record are attributed to water level impacts at the spring from wildlife and human visitation.

Discussion

Surface water quality
The 1998-2005 surface water chemistry measurements should be considered a pilot study of NPS Water Resource Division core parameter monitoring in the monument. Tinaja water chemistry results from 1998 – 2005 can be used to determine future sampling frequency and instrumentation needs.

Quitobaquito springs
Flow rates at Quitobaquito southwest spring flume in 2005 averaged approximately 16 gallons per minute. Compared to rates reported by previous monitoring efforts of 28 gallons per minute between 1981 and 1992, current flow from the southwest spring is reduced to only 57% of historical rates. Quitobaquito pond water levels have declined significantly and outflow from the pond, formerly a perennial discharge, has not been documented since 1998. Pond levels

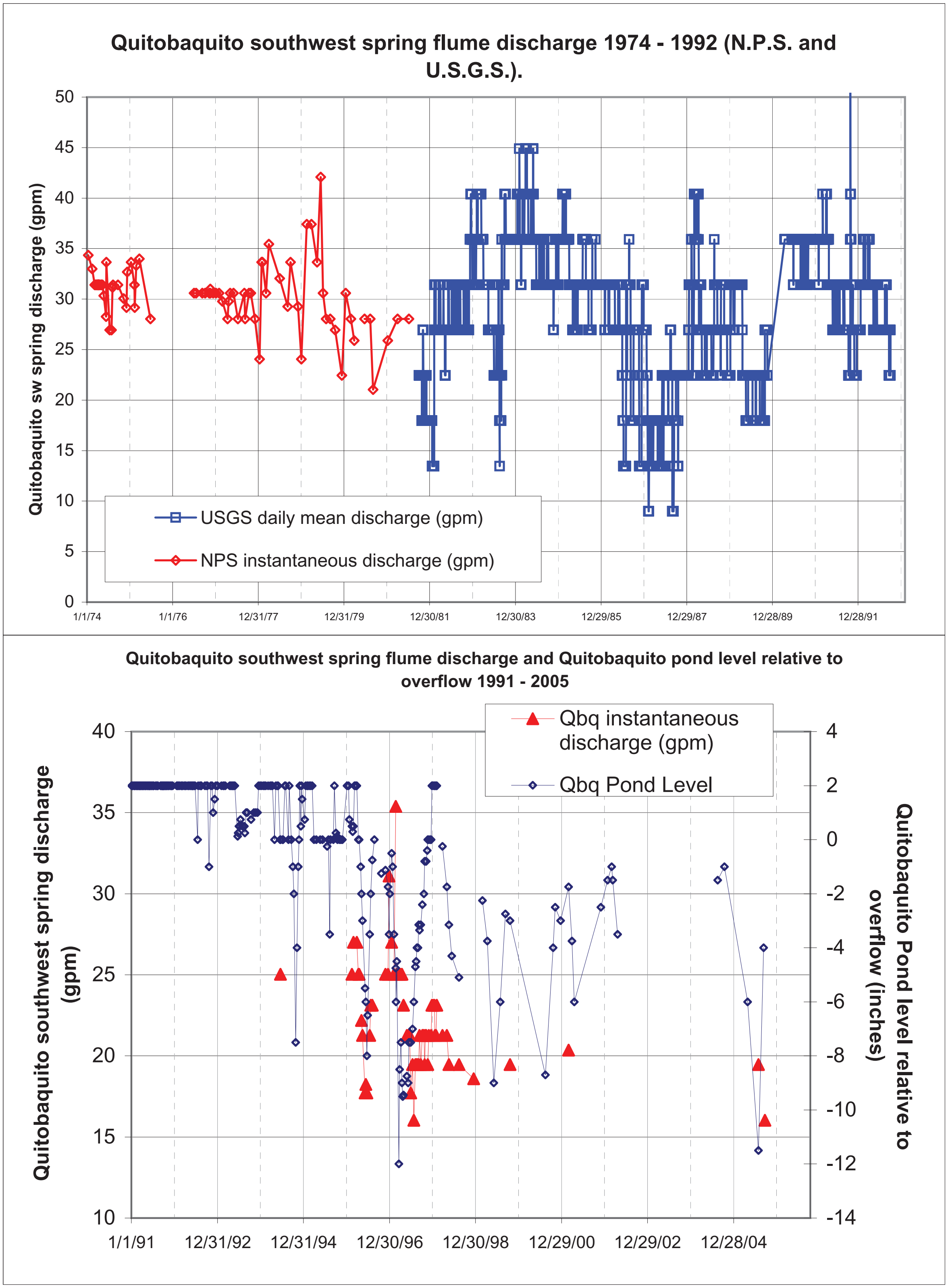

Figure 10. Quitobaquito southwest spring discharge 1974-2005 and Quitobaquito pond level, 1991-2005, Organ Pipe Cactus N.M. United States Geological Survey and National Park Service data.

in 2005 reached the lowest levels recorded since monitoring began in 1991 (Figure 14-10).

Nearby Burro Spring (formerly intermittent) and Williams Spring (formerly perennial) have ceased flowing completely in the last few years. These springs are located on the same high-angle fault along the southwest side of the Quitobaquito Hills discussed by Carruth (1996). Drying up of these springs in combination with decreasing flow rates at Quitobaquito Spring are probably related and indicate that there should be significant concern for the future viability of spring flows supporting Quitobaquito pupfish habitat. Also, vegetation growth in the springs area has become dense and may be contributing to the observed decline in discharge rate at the flume via evapotranspiration and/or clogging of the collection drains by roots. Groundwater pumping south of the border is an unquantified potential threat to the groundwater supply to Quitobaquito Springs. The likely existence of a hydraulic connection between groundwater in Aguajita wash and irrigation wells in Mexico is discussed by Carruth (1996).

Recommendations

- Results, methodology, site selection and monitoring frequency for surface water quality measurements should be reviewed by NPS hydrologists. Consultation and integration with the Sonoran Desert Inventory & Monitoring Network will assist in further analysis of past results, and developing future protocols for nutrient loading, biological conditions (with aquatic macroinvertebrates and algae indicators), and EPA priority metals.

- A groundwater monitoring system in the immediate source area of the springs should be planned and implemented, including a monitoring well installed in or near Aguajita Wash northeast of the Quitobaquito Hills.

- In cooperation with the Pinacate Biosphere Reserve staff, efforts to obtain groundwater level and pumping data from south of the border should be continued.

- In keeping with historical and ecological resource values associated with Quitobaquito spring and impoundment, it is recommended that a plan be made and funds sought for the purpose of submitting an application to Arizona Department of Environmental Quality for classification of the Quitobaquito spring and pond complex as a designated Unique Water in the State of Arizona. This designation constitutes formal recognition of the classified waters as outstanding state resource waters and provides greater protections than are afforded to undesignated waters.

Acknowledgements

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Table 14-1. Water quality results at Dripping Springs, 1998-2004, Organ Pipe Cactus N.M.

Date	Time	pH	Conductivity (µ/s)	DO-mg/L	Alk-- total	TDS (mg/L)	Water temp (C)	Air temp	Pool volume	Notes
27-May-98	1345-1445	7.2	365	1.79	92		16	25 C		
5-Sep-98	1500-1600	7.4	399	0.20	140	192	23	32 C		
4-Mar-99	1220-1320	7.18	340	0.48	97.6	164	14.5	21 C		
7-Oct-99	1330	7.28	371	1.32	84		19			
14-Apr-00	1345-1500	7.18	360	1.75	84-88	172	15.6	approx 89 F	pool overflowing	
16-Apr-01	1210-1250	7.24	289	4.90	52.8		13.2	mid 80s F	2” below damn lip	many bees, doves; migrant trash. Flies and dove feathers
15-Jul-01	1140	6.58	849	0.91	370		21.7		60 cm below dam lip	part of clean-up effort.
22-Jul-02		7.26	359	3.77			21.5		depth = .43 m at deepest point	
6-Dec-04	1117	7.03	327	7.70			11.6		pool full, some overflow	

Table 14-4. Water quality results at Jackson's Hole, 1998-2001, Organ Pipe Cactus N.M.

Date	Time	pH	Conductivity (µ/s)	DO-mg/L	Alk-- total	TDS (mg/L)	Water temp (C)	Air temp	Pool volume	Notes
27-May-98	1100-1200	7.45	547	0.45-.056	178.4		21			
5-Sep-98	1200-1330	7.4	468	3.60	142		25	27-32 C		
9-Apr-99	1150	6.86	912	3.89	42		11	15 C		
7-Oct-99	1100	7.83	551	5.43	61		20	80's F		
13-Apr-01	1250-1350	7.65	539	7.00	66		15.6	mid 70s F	10-12" deep	water clear

Table 14-5. Water quality results at miscellaneous sites in the Ajo Mountains, 1998-2004, Organ Pipe Cactus N.M.

Site	Date	Time	pH	Conductivity (µ/s)	DO-mg/L	Alk-- total	TDS (mg/L)	Water temp (C)	Air temp	Pool volume	Notes
Alamo near cistern	21-May-98	1630	7.5	266	7.93	n/a		25-27	30 C		
Bull Pasture "Deer Drop" tinaja	25-May-04	1920	8.06	256	8.68			16.7		approx 11x12 ft.	clear water
Bull Pasture "Juniper" tinaja	12-Oct-03		8.1		7.70		156	21.8	33.6 C		clear flowing water

Table 14-6. Water quality results at Tinaja Estufa and Hidden Gorge Tinaja, 2000-2004, Organ Pipe Cactus N.M.

Site	Date	Time	pH	Conductivity (m/s)	DO-mg/L	Alk-- total	TDS (mg/L)	Water temp (C)	Air temp	Pool volume	Notes
Tinaja Estufa, above dam	25-Aug-03	1640	10.64	308	16.70			34.1	41.2 C		
Tinaja Estufa, above dam	23-Sep-03	730	8.33	311			167	24.1			
Tinaja Estufa, below dam	4-May-00	900	8.63	451	5.43	125		20.5			
Tinaja Estufa, below dam	25-Aug-03	1550	10.48	220	15.70			34.7	41.2 C		
Tinaja Estufa, below dam	23-Sep-03	730	9.98	117	7.50		62	24.3	26.8		
Tinaja Estufa, below dam	24-Oct-04		8.89	233	12.00			20			
Hidden Gorge Tinaja	4-May-00	1000	7.68	501	0.49	145		20		approx. 2' deep, 4.5' x 30"	

Table 14-7. Water quality results at South Alamo Canyon, 1998-2004, Organ Pipe Cactus N.M.

Site	Date	Time	pH	Conductivity (m/s)	DO-mg/L	Alk--total	TDS (mg/L)	Water temp (C)	Air temp	Pool volume	Notes
Jacuzzi tinajas	3-Sep-98	1015	8.06	278	4.78		130	26	29 C		
Jacuzzi tinajas	12-Apr-99	1100-1300	10.68	312	10.50	41	147	12.8	18.5 C		
Jacuzzi tinajas	1-Oct-99	1200-1330	9.02	221	3.09	28-67	105	23.9-27.4			
Jacuzzi tinajas	5-Apr-00	1330	6.98	297	11.60	74		18.3-22	89 F		
Jacuzzi tinajas	12-Apr-01	1545-1700	7.09	305	9.60	73.6		19.4	70-74 F	full, inflow and outflow	water clear, no algae
Jacuzzi tinajas	29-Aug-01										
Jacuzzi tinajas	16-Jul-02	900	7.23	313	1.71			25.5		pool level approx. 4” below top	
Jacuzzi tinajas	11-Sep-03	1540	9.96	226	14.50			29.9	36.7 C		
Jacuzzi tinajas	24-May-04	1852	8.87	344	11.14			23.2		approx: 7’ x 4’ x 3’ depth	tinajas full & flowing, tinajas below Jacuzzi full, clear water, many tadpoles
pool below jacuzzi tinajas	3-Sep-98	0815-0945	8.2	250	2.36	116	166	24	27 C		
pool below jacuzzi tinajas	12-Apr-99	1300	7.25	255	7.78	40	120	13	20.7 C		
S. Alamo--upper gorge	16-Jul-02	1020	7.31	318	1.25			25		approx. 12’ x 6’ pool	tinaja covered with thick layer of algae

Table 14-8. Water quality results at Wild Horse Tank, 1998-2004, Organ Pipe Cactus N.M.

Date	Time	pH	Conductivity (m/s)	DO-mg/L	Alk--total	TDS (mg/L)	Water temp (C)	Air temp	Pool volume	Notes
12-Feb-98		9.99	187.4	15.49				23.4 C		
20-May-98	1600	8.63	278	--			18.5	31.5 C		
7-Sep-98	1530-1620	8.76	175	13.26	73-82	79	30	34 C		
10-Mar-99	1600-1730	8.73	401	13.51	174		17.6	19.7 C		
12-Oct-99	1030	8.04	370	5.93	131		20			
11-Apr-00	1255	9.73	237	16.60	93		18.1-22.7	90 F		
12-Oct-03	1040	9.16	276	11.70		144	23.5	30 C		
31-Jan-05	1145	8.35	321	10.10		159	12.7	66 F	approx. 12 x 12 m	upper pools also have water; tank cloudy w/algae,
late May 04		8.26	289	8.55						

Table 14-9. Water quality results at Quitobaquito southwest spring pool, 1998-2005, Organ Pipe Cactus N.M

Date	Time	pH	Conductivity (m/s)	DO-mg/L	Alk--total	TDS (mg/L)	Water temp (C)	Air temp
11-Feb-98		7.54	1112	6.03	254		24.9	
24-Jun-98	1700	7.54	1355	4.83	240		25.1	
25-Jun-98	45			5.29			25.4	
25-Jun-98	831			5.13			25.5	
25-Sep-98	1030	7.59	1132	5.68	176		27	
17-Feb-99	1420-1545	7.52	1148	5.60	222		24.4	
24-Jun-99	1825	7.48	1160	5.92			26	
24-Sep-99	1345-	7.51	1120	5.93	209		28	
10-May-00	1240	7.36	1136	5.58	152		26.1	
25-Apr-02	1350	7.67	1179	5.70			25.7	37.2 C
10-Dec-02	--	7.5	1114	6.40			25.4	19 C
5-Sep-03	1028	7.58	1159	5.78	224		27.2	32.3 C
26-Mar-04	1111	7.44	1165	5.80			24.7	30.1 C
27-Jan-05	1225	7.43	1191	8.31		603	24	

Table 14-10. Water quality results from Quitobaquito mid-channel pool, 1998-2005, Organ Pipe Cactus N.M.

Date	Time	pH	Conductivity (m/s)	DO-mg/L	Alk--total	TDS (mg/L)	Water temp (C)	Air temp
11-Feb-98		8.01	1178	7.50	256		24	
24-Jun-98	1745	7.88	1374	5.86			25.5	35 C
25-Jun-98	50			6.57			24.1	
25-Jun-98	835			6.84			24.9	
25-Sep-98	1050	8.06	1127	7.17			27	
17-Feb-99	1430	8.05	1143	7.48			23.8	
24-Jun-99	1815	7.88	1158	6.95			26.4	
24-Sep-99	1405	8.06	1138	8.16			28	
10-May-00	1220	8.14	1137	9.83			27	
25-Apr-02	1330		1191	8.30			27	35.8 C
10-Dec-02	--	7.94	1115	6.70			24	19 C
5-Sep-03	1045	7.98	1160	7.34			27.8	33.9 C
26-Mar-04	1120	7.87	1169	7.87			24.5	
27-Jan-05	1200	7.89	1183	6.07		598	24	20.7 C

Table 14-11. Water quality results at Quitobaquito Pond, 1998-2005, Organ Pipe Cactus N.M.

Site	Date	Time	pH	Conductivity (m/s)	DO-mg/L	Alk--total	Water temp (C)	Air temp
QBQ-pond, boat launch	11-Feb-98		8.81	1170	10.83		17.5	
QBQ-pond, boat launch	24-Jun-98	1900	9.56	1591	15.30	252		
QBQ-pond, boat launch	25-Jun-98	930	9.53	1328	6.72		26.7	
QBQ-pond, boat launch	24-Sep-98	1000	9.6	1365	1.49		26	
QBQ-pond, boat launch	25-Sep-98	1000				206		
QBQ-pond, boat launch	17-Feb-99	1530	8.99	1159	14.30	203	15	25.8 C
QBQ-pond, boat launch	24-Jun-99	1740	9.79	1552	11.60		33.26	
QBQ-pond, boat launch	24-Sep-99	1430	9.88	1299	13.44	181	34.5	
QBQ-pond, boat launch	10-May-00	1130	9.74	1352	6.15	157	28	
QBQ-pond, boat launch	25-Apr-02	1420	9.8	1382	12.50		31.7	
QBQ-pond, boat launch	10-Dec-02	--	8.87	1184	6.10		13.8	19 C
QBQ-pond, boat launch	5-Sep-03	1100	9.28	1322	8.10	186	32.6	34.4 C
QBQ-pond, boat launch	26-Mar-04	1130	9.11	1209	9.10		23.7	
QBQ-pond, boat launch	27-Jan-05	1245	8.46	1149	8.70		18	
QBQ-pond, middle	24-Jun-98	1830	9.56	1591	15.30	n/a	32	28 C
QBQ-pond, middle	24-Sep-98	1000-1055	9.45	1363	7.51/9.5-10.5	n/a	26	30 C
QBQ-pond, middle	17-Feb-99	1600	8.95	1175	15.43		18	
QBQ-pond, middle	24-Jun-99	1840	9.71	1333	15.90		33.6	
QBQ-pond, middle	24-Sep-99	1305	9.44	1301	15.21		32.9	
QBQ-pond, middle	10-May-00	1150	9.79	1328	9.20		27	
QBQ-pond, middle (no veg)	25-Jun-98	111			9.76		27.6	
QBQ-pond, middle (no veg)	25-Jun-98	812			7.73		25.8	
QBQ-pond, middle (w/aquatic veg)	25-Jun-98	107			9.95		26.6	
QBQ-pond, middle (w/aquatic veg)	25-Jun-98	808			7.56		24.8	
QBQ-pond, cottonwood	24-Sep-98	1000-1055	9.58	1382	11.40		26	
QBQ-pond, deepest area	24-Jun-98	1845	9.52	1624	13.90	n/a	31.5	
QBQ-pond, deepest area	10-May-00	1205	9.83	1352	7.77		28	
QBQ-pond, deepest area (no veg)	25-Jun-98	821			5.39		25.7	
QBQ-pond, deepest area (open)	24-Sep-98	1000-1055	9.44	1394	8.71	n/a	26	
QBQ-pond, deepest area (shade)	24-Sep-98	1000-1055	9.39	1415	4.25	n/a	25	
QBQ-pond, deepest area (veg)	25-Jun-98	114			9.22		27.6	
QBQ-pond, deepest area (veg)	25-Jun-98	817			6.40		26.2	