



National Park Service
U.S. Department of the Interior

Organ Pipe Cactus
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Biological Assessment
Emergency Actions to Stabilize Quitobaquito Pond
Part II: Renovating the Southeast Corner
ESA Emergency Consultation #22410-2008-FE-0273
October 2009

Summary:

Quitobaquito Pond lies on the international border near the southwestern corner of Organ Pipe Cactus National Monument (ORPI). Quitobaquito is comprised of multiple special-status cultural and natural resources, including the endangered Quitobaquito (aka Sonoyta) pupfish (*Cyprinodon eremus*) and the Sonoyta mud turtle (*Kinosternon sonoriensis longifemorale*), a candidate species.

In 2006 and 2007, the surface elevation of Quitobaquito Pond fell to extremely low levels, unprecedented in the history of the pond since it was dredged and deepened in 1962. These drops in water level were presaged by a smaller reduction in midsummer 2005. Normally averaging about 25" to 42" deep (outflow pipe level) and about 29,000 ft² in surface area, by late 2007 the pond had fallen to 23.25" below the outflow pipe (18.75" deep), and was 70% of its normal surface area. This loss of surface area and total water volume presented imminent threats to the Quitobaquito pupfish, Sonoyta mud turtle, and the overall natural and cultural resources. Initial evaluations and management actions assumed the water deficit was caused by long-term drought affecting spring discharge, and overdue maintenance of the spring collection system. While those factors contributed to diminished water supply, by late 2007 additional evaluation and rapid water loss indicated substantial loss of water from the pond itself, over and above normal evaporation and plant transpiration. A leak in the retaining berm forming the pond, or elsewhere in the pond margin or bottom, was strongly suspected.

In the effort to understand and rectify the low-water situation at Quitobaquito, in 2006 through 2009 ORPI undertook multiple management actions, assessed results of inspections and monitoring, and consulted with experts, partners, and interested parties. These actions included renovating the northeast spring (2007), increasing emergent plant management (2006-2009), repairing the stream channel (2005-2009), evacuating pupfish and mud turtles (2007-2009), installing a diaphragm wall in the retaining berm (ORPI 2008a), trucking water to supplement the pond (ORPI 2009), and others (see "Background" below). All these actions ameliorated the situation to a certain extent. However, the March 2009 water-hauling project had two purposes: 1) To raise the pond level in a controlled, closely measured fashion to evaluate its water-holding integrity, and: 2) To supplement the pond prior to the upcoming warm-dry months of midsummer. That effort demonstrated that a large-scale leak from the pond was still active, causing the unexplained loss of 9 to 14 gallons/minute. While large volumes of water clearly were lost in short time periods, evidence of the escaped water has never been found adjacent to or near the pond. The lost water appears to be going straight down into the earth, leaving no evidence as localized damp areas or lush plant growth. The retaining berm remained a highly

suspect area, particularly in the areas of the southeast corner, the leaning cottonwood, and other areas where larger trees had been rooted in the berm. In midsummer 2009, nontoxic tracer dye was used in the pond to attempt to determine the leak location. Effectiveness of this technique was probably compromised somewhat by extremely shallow water, breezy conditions, and up to 16" of organic detritus and mud overlaying the pond bottom. However, after four trials, the most consistent dye movement observed was toward the southeastern corner. Based on these observations and other circumstantial evidence (presence of larger trees rooted in the berm, and other possible damage), the NPS elected to carry out a renovation limited to the southeast corner. First, extensive bulrush encroachment was removed from the inner face of the retaining berm and pond bank. Then, approximately 4,500 ft² of the southeast corner was isolated from the rest of the pond, by constructing a temporary coffer dam. All possible Quitobaquito pupfish and Sonoyta mud turtles were either relocated from the southeast corner to the remaining pond (pupfish) or removed for temporary safekeeping offsite (mud turtles). The southeast corner was then emptied of water, mud, and detritus. The retaining berm was widened inward approximately 4 feet, using compacted clean fill material. A bentonite wall was built into the center of this enlargement of the berm. Finally, the pond bottom was covered with about 6" of compacted bentonite and fill mixture.

The southeast corner renovation project was funded primarily by base park funding, supplemented by emergency NPS border-mitigation funds. The project was carried out primarily by ORPI staff, with generous assistance from the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, and other NPS units (See Acknowledgements and Appendix I).

Compliance

Endangered Species Act: This project was carried out under the emergency provisions of Section 7 of the ESA. In April 2008, an emergency consultation (#22410-2008-FE-0273) was established with the USFWS, to carry out emergency actions to stabilize Quitobaquito Pond. That initial phase concerned constructing a diaphragm wall in the retaining berm, and related actions (OPCNM 2008). Because that action did not substantially improve the status of the pond, the additional actions described in this document were carried out, under the existing and open emergency consultation, and in close coordination with the USFWS-Arizona Ecological Services, and the AGFD. This biological assessment updates a pre-project, April 2009 draft biological assessment.

National Environmental Policy Act: This project was carried out under categorical exclusion 3.4C(3): Routine maintenance and repairs to non-historic structures, facilities, utilities, grounds, and trails. (NPS Director's Order 12). Although the berm and pond are considered to be historic structures, we did not anticipate effects on the structure would be significant, as defined by NEPA. The berm itself was not be disturbed, it was simply widened in selected areas. This finding allowed use of a categorical exclusion. Compliance documents for this project are stored in the NPS' Planning, Environment, and Public Comment (PEPC; <http://pepc.nps.gov/>) online database, project number 27199.

National Historical Preservation Act: Because cultural resources were present, but the action was undertaken to preserve cultural (and natural) resources, a No Adverse Effect assessment is warranted.

Project Area

The project area is Quitobaquito Pond, in Organ Pipe Cactus National Monument (Figures 1 and 2). The Quitobaquito area, which includes the springs, stream and pond, lies on the international border, within the Rio Sonoyta watershed, approximately 14 miles west of Lukeville, Arizona.

Quitobaquito springs originate from the Aguajita Wash aquifer and rise from the fractured granite and gneiss of the Quitobaquito Hills. The two largest springs are captured and conducted into a manmade (gunnite) stream channel, which flows south approximately 800 feet (244 m) to the pond. Other springs in the immediate area result in small natural seeps with no significant pooled water. Although Quitobaquito lies mostly within designated wilderness, Mexico Highway 2 also lies approximately 100 meters (328 ft) to the south and is primary land transportation link between mainland Mexico and the Baja California peninsula. Quitobaquito is internationally recognized as a unique, rare desert oasis supporting an exceptional assemblage of wetland organisms including endangered, rare, endemic, and cultural heritage species, and a locally high biodiversity. Quitobaquito also contains significant cultural resources, and is a favored visitor destination. The Quitobaquito area has traditionally been used by Native American Indian tribes, park visitors, scientists, and as an illegal border crossing point. The latter use currently ranges from serving as a *de facto* rest stop along Highway 2, to functioning as a staging point for smuggling and illegal immigration. Currently, the Quitobaquito area is closed to the general public, due to safety concerns.

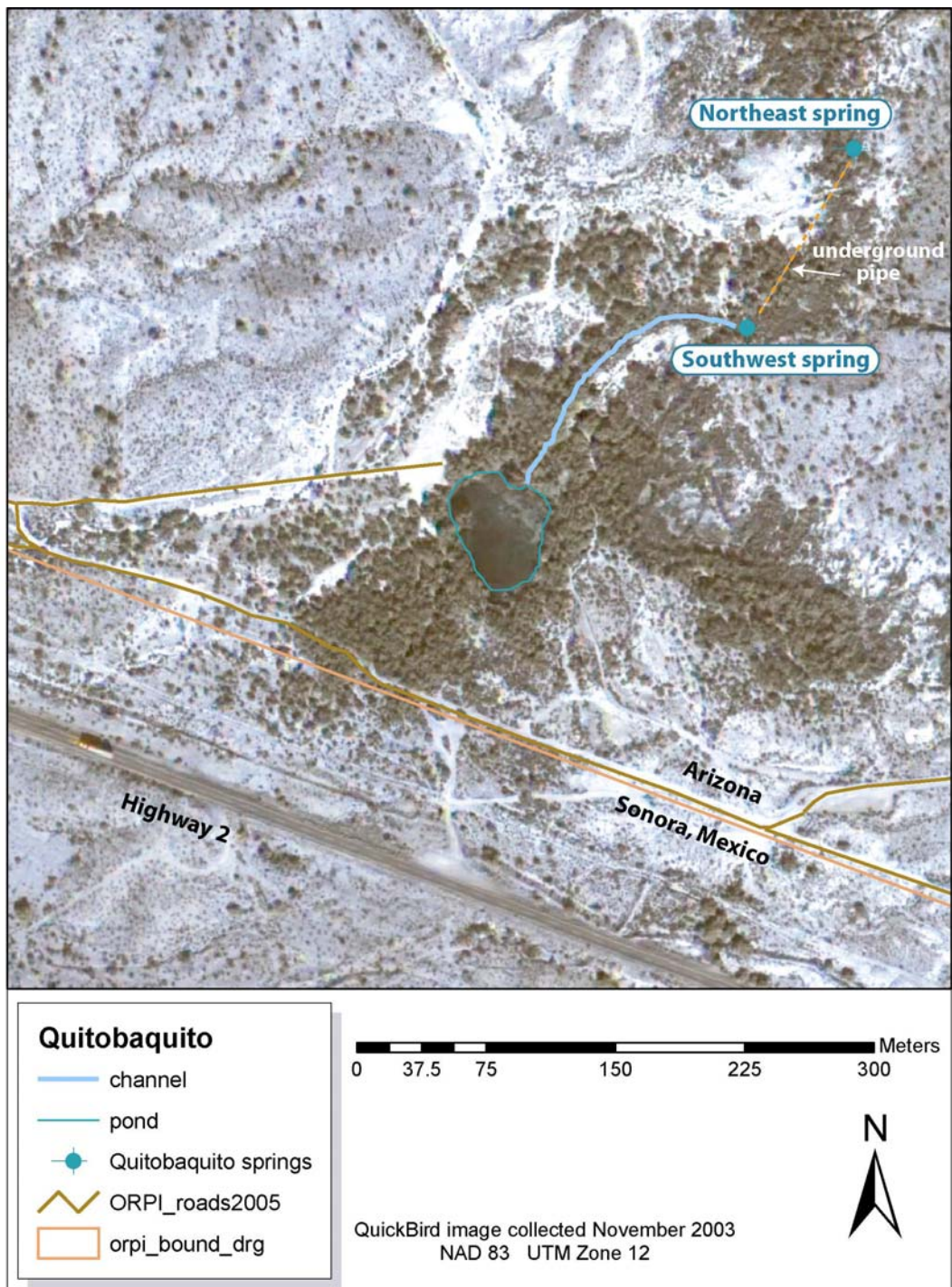


Figure 1. Quitobaquito Springs, Pond, and surroundings. Organ Pipe Cactus National Monument, Pima County, Arizona.



Figure 2. Aerial view, Quitobaquito Pond. Blue line indicates alignment of the temporary coffer dam, separating the southeast corner from the remainder of the pond. Photograph December 10, 2008.

We consider the project area to be within critical habitat designated for the desert (Quitobaquito or Sonoyta) pupfish (March 31, 1986 (51 FR 10842). The designation includes:

“Quitobaquito Spring, approximately 25 miles (*sic*) WNW Lukeville, Arizona, in Organ Pipe Cactus National Monument, Pima County, Arizona. T17S, R8N; and a 100-foot riparian buffer zone around the spring.”

The following endangered species occur in the project area:

Quitobaquito (Sonoyta) pupfish (*Cyprinodon eremus*)
Sonoran pronghorn (*Antilocapra americana sonoriensis*)
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuanae*)

Background

Quitobaquito Pond was last dredged, deepened, and the retaining berm enlarged, in 1962. Since then the pond has averaged about 25" (north shore) to 42" deep (south shore) and approximately 29,000 ft² in surface area. The maximum surface elevation is controlled by an outflow pipe placed in the retaining berm, and a concrete spillway at approximately the same elevation in the southeast corner. Until the early 1990s, water commonly flowed through the outflow pipe most of the year. A long-term drought began in the early-mid 1990s, and continues today. With diminished rainfall, spring discharge has also gradually diminished, from approximately 25-30 gpm in the early 1990s to 15-19 gpm since the late 1990s. With diminishing spring input and extending drought, water has rarely flowed through the outflow pipe after 1997. Minor seasonal fluctuations in surface elevation were common, with the pond level lowering slightly during the spring and autumn dry seasons. Seasonal reductions were typically 2" to 4", with the pond rarely dropping to more than 6" below the outflow pipe. In July 2005, a record low level of 11.5" below the outflow pipe was recorded. The pond then quickly recovered to minus 4" after summer rain input.

In 2006 and 2007, the surface elevation of Quitobaquito Pond fell to extremely low levels, unprecedented in the history of the pond in its current configuration. In 2006 and 2007, the surface elevation reached new record low levels, of minus 18" and minus 23.25" respectively (18" and 23.25" below outflow pipe). The latter level was reached when the pond level fell more than 15" in 45 days in September-October 2007, a time when the pond experienced rain input and reduced evaporation losses. This low level resulted in the pond's bottom mud layer being exposed in some areas, with additional areas only 1" to 2" deep. This loss of surface area and total water volume presented imminent threats to the endangered Quitobaquito pupfish and the Sonoyta mud turtle, a candidate species. With loss of the pond seeming imminent, 1,048 Quitobaquito pupfish and 13 Sonoyta mud turtles were evacuated to temporary holding facilities at the Arizona-Sonora Desert Museum.

In 2006 and early 2007, initial evaluations and management actions were based on a belief that the water deficit was caused by long-term drought (affecting spring discharge) and overdue maintenance of the spring collection system. While those factors certainly contribute to diminished water supply, by late 2007 additional evaluation and rapid water loss indicated substantial loss of water from the pond itself, over and above normal evaporation and plant transpiration. Water budget calculations for the Quitobaquito system resulted in an estimate of over 9 gallons of water per minute being lost to an unknown cause, in March 2008. A leak in the retaining berm forming the pond, or elsewhere in the pond margin or bottom, was strongly suspected.

Throughout 2007-2009, Organ Pipe staff carried out extensive examination, monitoring, and management of the Quitobaquito system. The monument was substantially assisted in this process by NPS hydrologists. We also consulted additional authorities in a variety of state, federal, and Tribal agencies. In April 2007, the northeast spring collecting pipe was replaced. It had last been replaced in 1989. Once excavated, no apparent occlusions or other problems were found in the old pipe. After installing a new collecting pipe, no net increase in spring discharge was achieved. Through summer 2007, NPS staff cleared emergent vegetation from the southwest spring (an open trench) and the stream channel. Several locations were located where water was being lost from the stream channel, due to ground subsidence changing the vertical alignment of the channel. Some of these areas were repaired, by building new, higher concrete rims on the channel. These actions reduced the net loss of water from springheads to pond, from about 5 gpm to just over 1 gpm. By July 11 2007, the pond level had gradually lowered to a new record low of

minus 20.2". With the onset of summer rains, the pond level recovered to minus 8.1" by September 6. However, between September 6 and October 22, the pond level fell precipitously to -23.25" at a rate of 0.33" per day. After estimating losses to evaporation and plant transpiration, this lowering level was estimated to be due to loss of approximately 14,000 gallons/day, or 9.6 gpm, due to unknown causes, (Spring input was approx. 19,440 gallons/day, and pan evaporation rate estimated to be 3,871 gal/day). While evaporation and transpiration losses were potentially coarse estimates, the precipitous loss of water during autumn months was unprecedented, when compared with other years having similar rates of spring input, and losses to transpiration and direct evaporation.

Quitobaquito Pond reached minus 23.25" on October 22, 2007, and held at that level through November 27 (47 days). That stable surface elevation, immediately following a 45-day-long precipitous drop, led NPS staff to believe there was likely a leak in the pond perimeter at or near the minus 23.25" level, which was controlling the pond surface at that level. The pond level increased to minus 20.5" from November 27 to January 8, 2008. This increase corresponded with over 3" of rain in the area. Staff speculated that rain input, combined with slightly increased spring input and reduced winter evaporation and transpiration may have allowed system inputs to temporarily exceed the rate of a leak.

In October-December 2007, NPS staff made numerous detailed examinations of Quitobaquito Pond in attempts to locate a leak. We removed extensive vegetation from the retaining berm to allow close inspection of the berm. We examined the land and vegetation adjacent to the pond on all sides, searching for damp earth or unusual, local "greenup" of vegetation, or other indications of seepage. We inspected the inside bank of the entire pond perimeter for possible leaks. None were located. We did not interpret those negative findings as disproving the likelihood of a leak. Instead, we suspected a significant leak could take place entirely below the ground surface, with water moving down into the earth leaving no surface evidence. A major suspected source for this type of leak was the presence of large trees on the retaining berm. After the 1962 berm enlargement, no effort was made to control vegetation growth on the berm. As a result, by January 2008 there were 18 medium-to large mesquite trees, both live and dead, rooted on the berm. There was also one large (but decadent) Goodding's willow, several large wolfberry, and a large, decadent Fremont cottonwood, all growing on the berm. The latter tree, subject of many photographs, is rooted in the crest of the berm, and has progressively leaned into the pond to the point where now the trunk is oriented below the horizontal for about 5 meters, at the typical water surface elevation. The tree is decadent, with open cavities observable and palpable in the main trunk and root base.

The presence of 26 live and dead trees along the approximately 90-meter (340 feet) length of the berm presented a strong possibility that roots of at least one tree may have created a conduit for water to flow out of the pond into the surrounding earth. Quitobaquito Pond is underlain by highly fractured bedrock at fairly shallow depth. It is possible water could be moving through the berm and down into the bedrock at a relatively steep angle, leaving no surface evidence adjacent to the pond.

Park staff also investigated the possibility of theft of water from Quitobaquito; no evidence of this was found.

The apparent large-scale loss of water from Quitobaquito Pond was a direct and imminent threat to multiple resources. As aquatic organisms the Quitobaquito pupfish and Sonoyta mud turtle were most imminently threatened. With the 2008 spring dry season approaching with temperatures exceeding 100°F, the pond was expected to lower in surface elevation again. On

January 16, 2008, the pond surface was at minus 20.5", more than 13" lower than ever recorded in January of any year. At this low level, there was no margin of comfort. In the previous 2 years, the pond had lowered more than 12" during the spring dry season, March-June. If Quitobaquito Pond were to lower by 12" from minus 20.5", the pond would essentially cease to exist. All that would remain would be a small pool of approximately 300 square feet, 10" deep, in the southeast corner. Very large losses of Quitobaquito pupfish would occur – possibly 7,000 to 10,000 individuals of the 12,000 to 15,000 we estimated to be present in September 2007 (approximately 50% to 85% of the Quitobaquito population). About 1500 to 3000 would remain in the channel system, where water supply remains stable. Similarly, the Sonoyta mud turtle would face loss of perhaps 75% of the population. Beyond these impacts on special-status wildlife, Quitobaquito supports other important resources. The area presents cultural, aesthetic, archaeological, and visitor-experience resources which are all closely connected to presence of Quitobaquito Pond. If the pond is not stabilized and re-established, these resources will be substantially impaired.

As the water level reached new record lows in late 2007 and early 2008, Quitobaquito pupfish and Sonoyta mud turtles were evacuated to temporary holding facilities at monument headquarters, the Arizona-Sonora Desert Museum, Cabeza Prieta National Wildlife Refuge, and the Phoenix Zoo. Also in autumn 2007 and spring 2008, trees and shrubs were removed from the retaining berm to allow access to, and inspection of, the berm. In April-May 2008, a diaphragm wall was installed down the centerline of the retaining berm, in an attempt to stop suspected subsurface leaks and seepage. The diaphragm wall was made of concrete with pond liner on the outside wall, and extended to an average 6 feet below the surface of the retaining berm (See ORPI 2008a for full description). During construction, the berm interior was found to be damp through most of the northwestern 2/3 of the berm length. Also in that section, two areas of apparent seepage were found, each associated with tree roots. These findings encouraged optimism that the diaphragm wall might substantially reduce seepage from Quitobaquito Pond. However by early 2009, the pond level had not significantly recovered. In March 2009, we trucked 192,000 gallons of water to the pond in 5 days, raising the surface 7 inches. This effort was intended to test the capability of the pond to hold water. Unfortunately, the pond level fell again rapidly after the water supplementation – indicating loss of not only all the supplemental water, but also a large portion of the hourly input from Quitobaquito Springs (See ORPI 2009 for full description). This demonstrated a large leak persists, resulting in loss of up to 8 to 10 gallons per minute. The leak appears to be greater at higher pond levels (e.g. above minus 18"), and slower at extremely low levels (minus 22" and lower). This suggests the leak is influenced by water pressure, and/or lies in the pond sidewall somewhere around the minus 22" to 26" levels.

Also in spring 2009, ORPI continued consultation with interested parties and subject experts, including hydrologists, hydrogeologists, fish biologists, agency and Tribal representatives, and persons experienced with man-made ponds. The general consensus of these parties supported ORPI's assessment that renovation of the pond must be considered, either in one major action (as in 1962), or in smaller, sequential steps. For the latter approach, use of temporary coffer dams would be used to isolate sections of the pond, to test each for integrity and to allow some level of repair or renovation. This latter approach was attractive, for two important reasons:

- 1) Quitobaquito is a highly significant cultural site, in addition to its importance as aquatic habitat and designated critical habitat. Large-scale renovation should be avoided, even though the 1962 renovation caused greater ground disturbance than would be contemplated now. Full renovation in modern times would require a level of compliance (NEPA, ESA, NHPA) that would require possibly a year to complete.

- 2) Several localized areas of the pond were suspected as high-likelihood for a leak, e.g. the leaning cottonwood, the southeast corner, the northwest corner, and the retaining berm. If these areas could be isolated and a localized leak found and repaired, more extensive work and disturbance could be avoided.

Another valuable recommendation was to use tracer dye to attempt to locate the leak. This idea had been considered, but discounted on the belief that extremely shallow water, slow currents, and the 16" deep detritus layer overlaying the pond bottom would prevent tracer dye from being useful. As it turned out, these factors may have inhibited &/or obscured the performance of tracer dye, but did not prevent it from being instructive. In June and July 2009, nontoxic fluorescent tracer dye was used 4 times in Quitobaquito. The dye was squirted from shore, laying out lines approximately 10 feet out from and parallel to the berm, encircling the cottonwood, across the southeast corner, and at the channel inflow to the pond. Results varied from day to day, we suspect in part due to the action of wind on the extremely shallow water. Two observations were most compelling: 1) Although dye was placed near the leaning cottonwood 4 times, it never moved toward the trunk of the tree; 2) After each of the 4 uses of tracer dye, dye ended up in the deep pool of the southeast corner (Figures 3a and 3b). On two separate days while conducting the dye trials, leaf litter and other material lying on the water surface in the southeast corner were observed to be moving in a slowly rotating pattern.



Figure 3a. Quitobaquito Pond, immediately after placing red nontoxic tracer dye. View is from the leaning cottonwood southeast, into southeast corner. Dye was squirted from the retaining berm (right) and across the southeast corner (back center). June 12, 2009.



Figure 3b. Quitobaquito Pond, three hours after placing the nontoxic tracer dye in Figure 3a. View is from the leaning cottonwood southeast, into southeast corner. Virtually all dye has moved from along the south/berm shore (right) into the southeast corner (back center), where a pinkish hue is visible. June 12, 2009.

The tracer dye exercise reinforced existing suspicions regarding the southeast corner. That corner has an area of about 400 square feet where the pond bottom is 18" or more deeper than the rest of the pond. The records of the 1962 renovation are insufficient to determine whether that area was dredged/excavated that much deeper, or if the deeper area developed since 1962. If the former, it is possible the 1962 work dug too deep, into water-permeable substrates, and it simply took 45 years for a problem to develop. If the latter, then some defect in the southeast corner has caused it to subside over the years, and begin leaking in 2005-2006. In addition, for many years a metal fence T-post was in the deep "well" area of the southeast corner, driven about 8" deep into the pond bottom. In March 2009 the post was removed, and the hole filled with bentonite and the area covered with pond liner. No change in the pond level resulted, so the T-post may not have been a leak source. However, it is possible the post hole was a leak, and simply was not sealed and continued to leak. Finally, several large trees were rooted on the inside edge of the retaining berm at the southeast corner. One of these was a decadent Goodding's willow (the "bee willow"); that tree and most of its root system were removed as part of the 2008 diaphragm wall project. However, one screwbean mesquite remained on the berm in the southeast corner, and the root system of a velvet mesquite whose above-ground mass was removed in 2008. Any of these trees, all inside the diaphragm wall on the inside edge of the berm, could account for a defect in the pond sidewall.

With the pond persisting at very low levels through 2008 and into 2009, bulrush (*Schoenoplectus americana*) encroached extensively into the pond. Dense bulrush stands have encroached up to 32 feet (10 m) or more from the former pond edge, toward the pond center. Encroachment is most extensive at the shallow north and east sides of the pond. In those areas, the combination of extreme low water and dense bulrush stands had created "new" land so substantial that seedlings of mesquite and tamarisk were abundant within the bulrush, in what had recently been open-water pond. In winter 2008 and early 2009, we manually cleared approximately 1,400 square feet of bulrush stands, down to and including the root masses (Figure 5). However, this effort reclaimed only about one-third of the 2008 encroachment. An increasing island of bulrush beneath the cottonwood tree could not be removed due to presence of Africanized honeybees in the cottonwood. In July 2009, single pioneering bulrush shoots were visible across much of the pond. This foreshadows the fact that, if the pond water level is not raised soon, the pond will fill in with contiguous bulrush stands, possibly within 12 months or less.



Figure 4. Quitobaquito Pond at minus 26" level. May 2, 2008. Panoramic view looking southeast from the west viewing bench. The exposed brown flats of mud and detritus would normally be covered by 18" to 26" of water. Most of remaining pond is 1" to 4" deep. Organ Pipe Cactus National Monument, Arizona.



Figure 5. Quitobaquito Pond, elevated view east from west bench, March 27, 2009. Pond level is minus 14.5 inches after large-scale water supplementation. Line of black dots at northeast shore (left rear) indicates area of bulrush removed in winter 2008-2009. Note enlarging bulrush island under cottonwood tree, in comparison with Figure 1.



Figure 6. Above: Piscivorous birds (snowy egret, great egret, white-faced ibis) feeding on Quitobaquito pupfish in abnormally shallow water, May 2008. Below: Omnivorous songbird, great-tailed grackle, feeding on pupfish in abnormally shallow water, June 2009. Quitobaquito Pond, Organ Pipe Cactus National Monument.

In spring-summer 2008 and 2009, we observed another, new threat to Quitobaquito pupfish resulting from extreme low water levels. During these times, the pond surface was 24" to 28" below the outflow pipe, leaving most of the remaining pond only 1" to 4" deep. This made pupfish vulnerable to piscivorous birds, in a way they are not when the water is deeper (Figure 6). During this time, we observed mixed groups of wading birds feeding heavily on pupfish, a phenomenon seen rarely if at all at normal water levels. Depredating birds included great egret, snowy egret, green heron, black-crowned night heron, black-necked stilt, and white-faced ibis. The latter two species are known more for feeding on invertebrates, not fish. However, at Quitobaquito they methodically took pupfish exposed and stranded in very shallow water. With up to 15 or 20 predatory birds sometimes present, we estimated up to 100 pupfish per hour were being predated during some parts of the day. This predation problem diminished in May, after the bird migration season had passed. In spring 2009, when the pond again fell below minus 26", even great-tailed grackles were observed feeding on pupfish (Figure 6). Vulnerability of pupfish to this omnivorous songbird underscores the severity of the situation.

Emergency Actions

On July 28, 2009, in a draft biological assessment submitted to the U.S. Fish and Wildlife Service, we proposed to take a series of actions, described and updated below. The goals of these actions were to restore a stable water level in Quitobaquito Pond, adequate to prevent imminent losses of Quitobaquito pupfish and Sonoyta mud turtles, for the near term (1 to 3 years). The actions described below were developed after extensive consultation with hydrologists, hydrogeologists, ecologists, biologists, and additional authorities in a variety of state, federal, and Tribal agencies. The actions were devised to attempt to address the low-water issue using the least intrusive means possible, to correct the most likely cause of water loss – a defect in the retaining berm or the pond bottom near the berm.

Description of Emergency Actions

Quitobaquito Pond has been leaking water since 2005, and at an acute rate since late 2007. The extremely low water levels persisting since late 2007 constitute a reduction in habitat for some sensitive species, e.g. Quitobaquito pupfish and Sonoyta mud turtle. Both species might be able to persist indefinitely at Quitobaquito under shallow-water conditions, although at substantially reduced populations. However, extended low water levels present additional threats. Pupfish and mud turtles alike are more vulnerable to predators in extremely shallow water. Perhaps more serious is the effect of bulrush encroachment, which is facilitated by shallow water. If the shallow water situation is not corrected soon, bulrush will fill in the pond, possibly as soon as mid-2010. If that takes place, it will result in profound reductions in pupfish and mud turtle habitat. A full-scale renovation (dredging and re-sealing) of the pond would then be the only way to reclaim this designated critical habitat.

Current information lead us to suspect the following areas as possible leak locations. Areas are listed in order of suspected severity:

1. Southeast corner: Long-term curiosity about the small deep “well” section, and presence of large trees in the retaining berm, and placement of a T-post in pond bottom, and a concrete spillway in the berm, led to suspicions regarding this area. Also, the fact that the pond continues to lose water even at the lowest levels suggests the leak is in one of the lowest places, also points toward this area. Finally, tracer dye testing consistently showed water movement into this corner, providing physical evidence of a leak there. A circular surface current observed twice in June 2009 may have been caused by wind, but also provided a compelling, almost comically “bathtub-drain” suggestion of a leak on the scale repeatedly estimated as 8 to 12 gpm.
2. Leaning cottonwood: Circumstantial evidence points to this area as potential leak. The tree is over 100 years old, senescent, dying, and rotting. It is rooted on the retaining berm, entirely inside the diaphragm wall, at the pond edge. Photographs illustrate that the tree has leaned almost 45° into the pond over the last 50 years. Bennett and Kunzman (1983) speculated the 1962 renovation may have accelerated the leaning, by removing supporting earth from underneath it. The trunk is now slightly below the horizontal, lying partly in the water at normal water levels. That leaning may have damaged the berm, and/or may be forcing part of the tree or reinforcing materials into the pond bottom. However, tracer dye testing consistently failed to suggest water movement toward the base of the tree.
3. Retaining berm: Despite constructing the diaphragm wall in 2008, the berm overall remains a possible leak zone. The wall should stop lateral water movement, and some

steep lateral-downward movement. Test excavations in 2009 revealed the berm interior is now dry outside the wall, and damp inside. However, the wall will not be effective stopping water moving straight down, from leaks low on the inner face of the berm. Tracer dye testing was inconclusive, with dye moving toward the center of the berm on 1 of 4 trials.

4. Northwest corner: This area became suspect in summer 2008, when it became an exposed, drying mudflat. The area became a shallowly-depressed bowl, cut off from the rest of the pond by slightly higher mudflats to the southeast. Several times when the pond level was raised slightly with trucked-in water, water flowed down into this bowl, refilling it. During tracer dye testing, on 1 of 3 trials dye moved into this corner; it was also the downwind corner on that date.

We originally proposed to undertake limited, site-specific renovations of one or more of the areas listed above. These renovations would be accomplished by first, isolating the suspected area(s) using a temporary coffer dam. The target area would then have all pupfish, mud turtles, water, sediment, detritus, and bulrush removed. The area(s) would then have supplemental sealant materials added to the existing pond bottom and inner banks. Supplemental sealant materials were expected to be a compacted mixture of earth and some amendment (bentonite, clay, or other), pond liner, or other materials. Target areas would be rejoined to the pond soon after renovation was complete, unless materials needed to set without water present, or unless greater complications (e.g. large leaks, fissures, etc) are discovered.

The proposed renovation actions took place from August 17 through 28, 2009. As it turned out, with the time and materials available, only the southeast corner renovation was completed. A day-by-day summary of activities follows:

Preparatory actions, June-July 2009

- Construct small experimental sandbag impoundment, north shore; disqualified larger-scale sandbag coffer dam as viable option.
- Consult with interested parties and cooperating agencies.
- Tracer dye trials
- Complete conceptual engineering design of project
- Complete draft biological assessment
- Design temporary coffer dam
- Purchase PVC for coffer dam frame, fabricate and package individual pieces
- Purchase and fill 400 sand bags
- Purchase pond liner, splice tape
- Evaluate fill amendment materials; bentonite selected
- Purchase fill material and bentonite
- Equipment acquisition, rental, inventory and preparation
- Finalize project plan
- Organize work force
- Organize security force

August 17, 2009: Removing bulrush

On-site project activities began with removing extensive, dense new growths of American bulrush (*Shoenoplectus americana*) that had established on the inner face of the retaining berm. This was done primarily to expose the area of the southeast corner to be renovated. However, removing this bulrush also served to reclaim pond volume that had been lost due to the bulrush encroachment. In the southeast corner since 2006, bulrush had expanded up to 25 feet and more inward, from the retaining berm into the pond. Bulrush was removed with a backhoe. At Quitobaquito Pond, bulrush tends to establish in dense stands whose root masses lay on top of, but do not penetrate, the hard pond bottom. Once cut into manageable-sized clumps, it lifts free of the pond bottom easily. The backhoe operator carefully placed the bucket against the firm pond bottom, then pulled toward the bank, tearing up the bulrush by the root masses, and deposited it on the retaining berm (Figure 7). Bulrush was removed up to the point where the original inner face of the berm was exposed, without cutting into the berm itself. Personnel inspected the removed bulrush for Sonoyta mud turtles, as it lay draining water on the berm. Four mud turtles were found in the removed bulrush. The bulrush was then removed from Quitobaquito. The total area of bulrush was a semicircle approximately 150 feet long and averaged 12 feet wide, or about 1,500 to 1,800 ft².



Figure 7. Removing bulrush encroachment and inspecting for Sonoyta mud turtles, southeast corner of Quitobaquito Pond, August 17, 2009.

August 18, 2009: Continue removing bulrush, Construct coffer dam, evacuate mud turtles

On this second project day, the bulrush removal described above was continued and completed. The large screwbean mesquite leaning over the deep “well” area of the southeast corner was also removed.

Concurrently, Sonoyta mud turtles (*Kinosternon sonoriensis longifemorale*) were captured throughout all areas of the pond. This was done to increase the number of mud turtles held in safekeeping off-site, pending restoration of the pond to a stable system. Mud turtles were captured by hand and with nets. Captured individuals were held temporarily in 5-gallon buckets and coolers. A total of 38 mud turtles were captured, including the four found in bulrush removed from the southeastern corner. One hatchling turtle was released into the stream channel system; the remaining 37 were transported by AGFD staff to the Arizona-Sonora Desert Museum for longer-term holding.

Concurrent with the above activities, a temporary coffer dam was installed, to isolate the southeast corner of the pond from the remainder. The coffer dam consisted of a PVC frame, supporting a pond liner water barrier. Sandbags were used to stabilize the structure and seal it against the pond bottom and banks (Figures 8 and 9). The coffer dam was 100 feet long, extending from the main berm, just west of the old spillway, then to the northeast, ending near the east shore bench. The coffer dam was placed at the top of a gentle slope in the pond bottom, which slopes down to the deeper water of the southeast corner.



Figure 8. Assembling the frame for the coffer dam, Quitobaquito Pond, August 18, 2009.



Figure 9. Completed coffer dam, Quitobaquito Pond, August 18, 2009.

August 19, 2009: Evacuating the southeast corner

This third project day was primarily dedicated to attempting to remove all possible Quitobaquito pupfish and Sonoyta mud turtles from the southeast corner. Dipnets were the primary method, although seine nets were also employed (Figure 10). Captured fish were immediately released, pouring them over the coffer dam into the remaining pond. After substantial numbers had been relocated, efforts began to remove the water from the southeast corner. Water pumps were used, having screens sufficient to exclude pupfish. Water was pumped from the southeast corner into the remaining pond. As water was drawn down in the southeastern corner, the pool contracted in surface area. This facilitated pupfish capture, as the remaining fish became more concentrated in a diminishing water volume. Work this day was terminated when the 3rd of three water pumps became inoperable, due to increasing volumes of detritus in the water.



Figure 10. Removing Quitobaquito pupfish and Sonoyta mud turtles from the southeast corner, Quitobaquito Pond. August 19, 2009.

August 20, 2009: Continue evacuating the southeast corner

On this date, effort resumed to clear the southeast corner of pupfish, mud turtles, water, and detritus. Modified pumping/filtration systems devised overnight were employed, with limited success. As the pool of relatively fluid water diminished to a small area in the deepest part of the corner, pumping and filtration were no longer possible. Organic detritus and mobilized sediment completely overwhelmed filtration systems, and threatened to damage the pumps. In addition, although netting pupfish had been effective, fairly large numbers of very small pupfish fry became visible in the diminishing and turbid water. These fry concentrated at the surface, apparently attempting to access oxygenated and relatively clear water. At this point, the last several hundred gallons of turbid water were moved over the coffer dam via bucket-brigade (Figure 11). An estimated 1,500 pupfish were relocated from the southeast corner into the remaining pond. In this process, 82 mortalities were observed. We suspect that additional mortalities occurred. These additional mortalities would have been very small fry (<10 mm), which became trapped in mud as the last relatively fluid water was moved over the coffer dam into the remaining pond. It is possible up to 300 small fry may have been lost in this manner.



Figure 11 Bucket-hauling turbid water and mud, containing pupfish fry. Water pump filtration system is visible in right center. Quitobaquito Pond, August 20, 2009.

August 21, 2009: Clearing the southeast corner

On this 5th day of project work, the southeast corner of Quitobaquito Pond was cleared of the remaining water, mud, and organic detritus. This was accomplished by hand-moving the saturated muck to the deepest part of the southeast corner, where a backhoe operated on the bank could dip it out (Figure 12). Workers used snow/scoop shovels, buckets, and a board scraper to move the mud/muck material. The material removed was placed on the outside/downhill side of the retaining berm; part of this material was hauled away later in the project.

As the firm bottom of the pond became exposed, it was found to be a uniform, smooth, hard-packed material of very high clay content. It appeared to be a constructed clay bottom. Historical records are not clear when this clay bottom was built. It may have been part of the major 1962 renovation of the entire pond, or might be much older. A distinct trough over 80 feet long was discovered in the hard clay bottom (Figure 13). It extended from the deepest part of the southeast corner, northwestward parallel to the berm, under the coffer dam, and into the main pond area. The trough was about 4" wide and 3" deep. This trough may have been a small man-made channel to conduct the spring-flow to the deepest part of the pond during the 1962 (or earlier) renovation. Its appearance also suggested a possible surface expression of an earth fissure, resulting from changes in the ground underlying the pond. On the inner face of the retaining berm, multiple areas of possible seepage were found, associated with the root systems of trees that had been allowed to grow on the retaining berm.



Figure 12. Removing mud and organic detritus from the southeast corner of Quitobaquito Pond. August 21, 2009.

August 24, 2009: Reinforcing the retaining berm and pond bottom

The southeast corner was allowed to dry out over the weekend of August 22 and 23. On this sixth workday on-site, work began to expand the retaining berm inward. A clean, reddish fill material consisting of particles 2mm diameter and smaller, with moderate clay content, was spread in 6" courses (lifts) approximately 4 feet wide, against the inner face of the retaining berm. A trench approximately 10" wide was then dug down the center of each course, to the depth of the course below (or the clay pond bottom, for the bottom course). Granular bentonite (3/8" "hole plug" grade) was then poured into this trench, and mixed with the material dug out to create the trench. Thus an inner wall of bentonite-enriched fill was created, at a concentration of 30% to 50% bentonite. Each course was then compacted with a vibratory plate compactor (Figure 13). As successive courses were built against the berm face, the new inner face sloped backwards at angles varying with and reflecting the inner slope of the original berm. Great care was taken to assure that the bentonite-enriched wall within each course was contiguous with the one below it. This served to create a single, continuous bentonite-enriched wall within the new fill, extending from the existing clay pond bottom to the top of the new fill material. Bentonite was no longer added to the new fill material, after the berm enlargement had been built up to a level approximately equal to the top of the outflow pipe.



Figure 13. Compacting bentonite-enriched fill against exposed inner face of the retaining berm. The pre-existing clay pond bottom is visible as a grey floor, drying out. The white arrow points to "the trough," visible as a faint dark linear feature fading into the damp area at the base of the coffer dam. August 25, 2009.

August 25, 2009: Reinforcing the retaining berm and pond bottom

On this date, work on expanding the retaining berm inward continued.

August 26, 2009: Reinforcing the retaining berm and pond bottom

On this date, work on expanding the retaining berm inward continued.

August 27, 2009: Reinforcing the retaining berm and pond bottom

On this date, work on expanding the retaining berm inward was completed. The initial layers of bentonite and fill material were compacted onto pond bottom. First, the “trough” was filled in with pure bentonite. Then, a layer of bentonite was spread on the pond bottom, at approximately 1 lb per square foot. Following that, approximately 2” of fill material were spread on top of the bentonite and the entire bottom compacted.

August 28, 2009: Reinforcing the retaining berm and pond bottom

On this date, reinforcing the pond bottom was completed. Another layer of bentonite was spread on the pond bottom, at approximately 2 lb per square foot (Figure 14). Following that, approximately 2” of fill material were spread on top of the bentonite and the entire bottom compacted. This sequence was repeated once again. The resulting new bottom was approximately 5” to 6” thick after compaction, with about 4 to 5 lbs of bentonite per square foot (Figure 15). The small deep well area of the southeast corner, approximately 10 feet in diameter, was originally about 20 inches deeper than the adjacent parts of the southeast corner. It was filled almost level with the rest of the pond bottom, using fill with high concentrations of bentonite.



Figure 14. Layer of bentonite (white) spread on the pond bottom, awaiting overlayer of red fill material prior to compacting. The former deep well area was in the lower left corner of this view. August 28, 2009.



Figure 15. Southeast corner of Quitobaquito Pond, renovated and sealed with a compacted mixture of clean earth and bentonite. August 28, 2009.

September 4, 2009: Opening coffer dam

On this date, jute erosion matting was placed over the new inside face of the retaining berm, to control erosion. Also, a small opening was created underneath the coffer dam, to initiate slow refilling of the southeast corner. To prevent erosion of the new material on the pond bottom, geotextile filter fabric was placed on the portion of the bottom where water flowed into the southeast corner. The system was left with water flowing into the southeast corner at approximately 10 gallons/minute.

September 16, 2009: Re-opening coffer dam

By this date, it was clear the opening under the coffer dam created September 4th had closed before the southeast corner filled completely. To correct the situation, a 1.5" diameter PVC pipe was placed under the dam to re-establish and maintain water flow.

September 23, 2009: Removing the coffer dam

With the southeast corner re-filled to a level equal to the rest of the pond, on this date the coffer dam was removed. The dam was disassembled fairly quickly, and all components removed from the pond, including sandbags. This process was carried out with little or no disturbance of the new pond bottom in the southeast corner (Figures 16 and 17). On this date, swelling of the bentonite-containing fill was observed on the new pond bottom and banks.



Figure 16. Quitobaquito Pond, September 23, 2009. Southeast corner (foreground) has refilled.



Figure 17. Quitobaquito Pond, September 23, 2009. Removing the last parts of the temporary coffer dam. Renovated/sealed southeast corner is left of the white dam frame.

Discussion

Before discussing the effects of this action on listed species, several related topics deserve discussion, for the administrative/management record and for their relevance to impacts on listed species and critical habitat.

Equipment Precautions

During this project, no heavy equipment was used within the pond. This precaution was observed for several reasons. One was a desire to avoid any chance of spill of toxic materials such as fuel, coolant, lubricants, or hydraulic fluid. Another major concern was to avoid disturbing the existing pond bottom. Prior to the midway point of this project, the NPS did not have a clear record or understanding of the composition and condition of the pond bottom. As is turned out, this precaution was particularly beneficial. The existing clay bottom appeared to be very solid, but when wet was fairly malleable. After it had dried it was a very hard surface, but could easily have been damaged by heavy equipment when wet.

A backhoe and small Kubota tractor were operated on the retaining berm, with the backhoe extending its bucket into the pond to clear bulrush and mud. This use of heavy equipment at the pond's edge was deemed acceptable and proved to be crucial in accomplishing the project. A single gasoline-powered plate compactor was used to compact all fill material inside the pond. This compactor was moved in and out of the pond by lifting it with a chain attached to the

backhoe bucket. The compactor was fueled outside the pond. No spills of fuel, oil, or other material occurred.

Volume of Fill Placed

This project resulted in a net increase in the current potential volume of Quitobaquito Pond. However, by placing new fill within Quitobaquito Pond, this project resulted in a net reduction in total potential pond volume, when compared to the pond immediately after the 1962 renovation. After compaction, the new bentonite/fill mixture occupied approximately 5,850 ft³ (216 yd³), all of which displaced *potential* water volume in the pond. A very rough estimate of the pond volume immediately following the 1962 renovation is 112,000 ft³ (32,000 ft² and averaging 3.5 ft deep). Thus the 2009 project reduced the total *potential* pond volume by about 5% from the 1962 condition. However the project resulted in a net increase in the *current* pond volume. From 1962 to about 2005, slow bulrush encroachment gradually reduced the pond surface area by about 4,000 ft² to 6,000 ft² (to about 27,500 ft²), primarily at the shallower waters of the north and northeast shores. Since 2005, rapid new bulrush encroachment has occupied nearly another 8,000 to 10,000 ft² or more. Most of this newer encroachment has not yet built completely dry land with its root masses, and is in standing water or has saturated root masses. However, the new growths still have substantially displaced a large volume of freestanding water. In addition, since 1962 a mud/detritus layer approximately 16" deep (1.3 ft) has been deposited across the entire pond bottom. In August 2009, this mud layer was entirely removed from the southeast corner (4500 ft² x 1.3 ft = 5,850 ft³). In addition, 1,500 ft² to 1,800 ft² of bulrush was removed from the banks. With the root masses averaging a thickness/depth of about 10" (0.83 ft), this project reclaimed about 1,370 ft³ of potential water volume by removing bulrush. Combining the volumes reclaimed by removing bulrush and mud, this project reclaimed approximately 7,220 ft³ of current potential water volume. Having displaced approximately 5,850 ft³ with fill material, this project resulted in a net increase of about 1,370 ft³ in current potential pond volume.

It is important to note that to some extent the mud, detritus, and bulrush removed in this project provided habitat and resources for the Quitobaquito pupfish and Sonoyta mud turtle. However, bulrush is expected to quickly re-colonize the new inner face of the berm, and begin re-establishing some of its beneficial habitat features. Also, because the southeast corner remains deeper and downslope from the rest of the pond, mud and organic detritus are expected to gradually flow downslope to cover the new pond bottom. Thus the potentially sterile appearance of the southeast corner immediately following the project is expected to be a short-lived phase. In fact, by early October 2009, pupfish were abundant in the southeast corner. Several new shoots of bulrush were establishing on the bank, and the reddish color of the new fill material on the pond bottom appeared to be acquiring the green-brown color of the normal pond mud/detritus.

The Pond Bottom, the "Trough" and "The Well"

The nature of the bottom of Quitobaquito Pond was poorly understood, but of increasing interest, as the low-water problems unfolded in 2006-2007. The bottom was assumed to be a firm earth material, to the extent it could be felt by hand, foot, or instrument, through the 16" depth of mud and organic detritus. Samples of the bottom taken in late summer 2008 revealed it to consist of a hard-packed, fine-grained, clay-containing material, and that the material was completely dry less than 3 cm below the pond bottom (Livingston 2008). The southeast corner renovation project provided current ORPI staff with their first clear, unobstructed view of any portion of the bottom of Quitobaquito Pond. Once exposed on August 21, the bottom was found to be a firm, smooth, uniform grey-white structure. It is unknown whether the bottom material is native, or was imported (in whole or part) for the purpose of building a watertight pond bottom. No detailed analysis of the bottom material has been done, but cursory examinations suggest it is not entirely native to rocks and soil materials at and near Quitobaquito. The high clay content is not typical

of soils in the area. Unfortunately, the historical record is vague on when this bottom may have been formed. Only two major workings of the pond are known. History credits Andrew Dorsey with building the original retaining berm and “digging” a pond, in 1860 (Bennett and Kunzmann 1983). However, since the site was occupied by humans for centuries or millennia prior to that, it is possible some type of water catchment predated Dorsey’s pond. Following Dorsey’s work, no subsequent major manipulation of the pond is known until 1962. That year, the NPS removed 4,164 cubic yards of “silt,” which was also described as “...excavat(ing) to the bottom of the organic material layer which was presumed to be the depth originally reached by Dorsey. . .” (Bennett and Kunzmann 1983). Bennett and Kunzman (1983) reported that the 1962 re-excavation went down until a “layer of white sand” was encountered, which was assumed to be the bottom established by Dorsey. The bottom material observed in 2008 and 2009 was whitish, but sandy only in that it was a mixture of fine sand, finer particles, and clay, molded into a hard continuous layer of unknown thickness.

Available history suggests no new clay bottom was constructed in 1962. Records make no mention of importing material or constructing a pond bottom. Historical photographs of the 1962 renovation reveal heavy equipment and trucks operating within the drained pond, with some disturbance of the bottom of the pond (Figure 18). However, it is unclear whether the disturbance (vehicle tracks and material windrows) consists of mud, “silt”, organic detritus, or a clay-containing material. Since the project description specifies only removing material, and deepening the pond to the suspected bottom created by Dorsey, it seems reasonable to conclude no clay bottom was built in 1962. This suggests the pond bottom is either: 1) A local combination of native materials, possibly formed under the influence of water, sedimentation, livestock, and other factors, or; 2) A human construction, probably made by Andrew Dorsey in 1860, possibly using imported amendments added to native materials.

ORPI staff have long been curious why the southeast corner of the pond was markedly deeper than the rest, containing a deep “well” area of about 350 ft² and nearly 20” deeper than the surroundings. Speculation has been that this deeper area was established in the 1962 renovation for some reason. This is supported by Bennett and Kunzman (1983), who interpret one photograph (Figure 18) as showing the southeast corner, with “approximately one foot of earth removed” - although it isn’t clear whether this means one foot of post-1860 sediment, or one foot of earth removed **below** the pond bottom established by Dorsey. The photograph clearly shows a corner of the pond (current interpretation concurs it is the southeast) that is deeper than the foreground portion, by perhaps several feet. Nearly 6 vertical feet of recent excavation seems apparent, when looking at the pond walls. The reason for deepening the southeastern corner may have been to provide a deep reservoir that would always have water, even if the rest of the pond went dry - as has nearly come true several times since 2006. If the clay pond bottom pre-dates 1962, and if the 1962 renovation excavated the southeast corner substantially deeper than the previous pond bottom, it is possible the pond’s capacity to hold water was compromised in that area. During this project, not quite all mud and organic detritus were removed from the bottom of the “well” area, due to time constraints. The clay bottom appeared to extend into the “well,” but this was not verified.

Observations of the existing clay bottom during this project lead to some new speculation regarding the major leak from the pond. The upper edges of the clay bottom were not exposed or located during this project. The clay bottom appeared to curve upward into the retaining berm. However, the outer/upper edge of the clay was not exposed, due to a desire to avoid excavating into the historic structure of the berm. However, it is possible the clay bottom rises only partway up the height of the berm, forming a shallow saucer. If that is true, it may be possible that with extended, multi-decadal drought still underway, the earth surrounding the pond is much drier than

in previous decades. This may cause water to spill over the rim of the clay bottom, underground, at a higher rate now than in the past.



Figure 18. Quitobaquito Pond, view from center of pond southeast, into southeast corner, January 1962. Photograph taken during major 1962 renovation. NPS File photo, W.F. Steenburg.

August 20, a distinct trough was discovered in the smooth clay bottom, while it was still covered by about 10" of mud. This trough was traced by feel, and was found to extend from the deep "well" discussed above, westward and under the coffer dam, a distance of about 40 feet (Figure 13). From that point, the trough was traced by feel another 40 to 50 feet into the remaining pond. It continued northwest, roughly parallel to the retaining berm and about 25 feet out from it. The trough then turned north and became indistinguishable, heading toward the center of the pond. Once exposed in the southeast corner, the trough was revealed to be a fairly uniform feature, about 4" wide and 3" deep. Its placement and dimensions strongly suggested a constructed water channel. ORPI staff speculated that, during the 1962 renovation (or before?), the channel may have been used to conduct the springflow directly to the deep well area, while the rest of the pond was emptied for renovation. A pump may have been placed in the deep well, pumping water over the berm at that point, to keep the pond temporarily dewatered. The linear appearance of the trough, combined with the water deficit problem of recent years, also invited a view of the feature as the result of a crack or fissure in the earth or bedrock underlying the pond. Considering that possibility, or that the trough was cut into the bottom in 1962, in this project the trough was filled in with pure bentonite, within the southeast corner.

Trend in Water Surface Elevation

The surface elevation of Quitobaquito Pond was tracked daily through the course of this project, and as possible in the following weeks. On August 17, the pond was 27.0" below the outflow pipe. This critically low level was comparable to the same date in 2008, and was the second full summer of acute low water.

On August 18, the temporary coffer dam was assembled, to seal off the southeast corner hydrologically from the remainder of the pond. No change in pond level was noted early the morning of August 19. Later that day, water pumped from the southeast corner into the remainder of the pond raised the level 0.5". The morning of August 20, approximately 40 hours after placing the coffer dam, the main body of the pond had raised another 0.5", to minus 26". We suspect the nearly 40-hour time period was required for the coffer dam to settle into place firmly and achieve an effective seal. The significant increase in pond level on August 20 was the beginning of a trend that has continued through October (Figure 19). The rising trend was interrupted only briefly, in mid-September when the coffer dam was opened to re-inundate the renovated southeast corner. That brief drop in the pond level was expected, as approximately 45,000 gallons flowed from the main pond into the southeast corner, refilling it and saturating the new bottom and sidewall material. By November 5, the pond had raised 10.75" in 79 days (0.136 inch/day), with virtually no rain, and no trucked-in water. The pond also rose in the face of greatly increased evapotranspiration losses (bulrush), hot, dry weather, and low spring input (13 gpm). There is no precedent in the last 20 years for the pond to rise so much, under such conditions. On November 5, 2009, the pond stood at minus 16.25", the highest level in 25 months, discounting the short-lived level of minus 14" achieved after massive water supplementation in March 2009. These developments strongly suggest the southeast corner renovation corrected a substantial part of the pond's water loss problem.

Since October 2007, we have been suspicious of the minus 23" level along the pond banks. Several times, after the pond rose above that level from rain events or trucked-in water, it quickly fell back to about minus 23 inches. That suggested a leak in the pond sidewall at that level, controlling the surface elevation of the pond. If the current trend raises and maintains the pond substantially above minus 23", it would be further evidence that the pond dynamics have changed significantly.

The Leak

As more weeks pass since the southeast corner renovation, with a steadily rising pond level, it appears more and more evident this project corrected a major part of the water deficit in Quitobaquito Pond. The specific location and cause of that leakage was not confirmed. If it was in the southeast corner, it was most likely one or several of the following:

- The 1962 renovation may have compromised a pre-existing clay-sealed pond bottom, by digging the “well” area &/or by cutting the “trench” feature. The damage may simply have taken 45 years to manifest.
- The retaining berm may have been compromised by the root systems of the “bee willow” (removed in April 2008) or the southeast corner screwbean mesquite (removed in August 2009). Both these trees were inside the diaphragm wall installed in 2008, so that structure may not have corrected damage caused by their roots.
- A fence T-post was placed in the pond bottom in the “well” area in the 1990s, as a mast for placing water monitoring data loggers. The post may have pierced the clay bottom, causing leakage. However, when the post was removed in March 2009 and the pond bottom patched with bentonite and pond liner, no improvement in the system resulted.
- The pre-existing clay pond bottom may be a very shallow saucer in shape. As a result of long-term drought and ground desiccation, and damage from tree roots, water may be spilling over the rim of that saucer, underground, at a high rate. The lowest point of that saucer, or greatest damage to it, may have been in the southeastern corner.

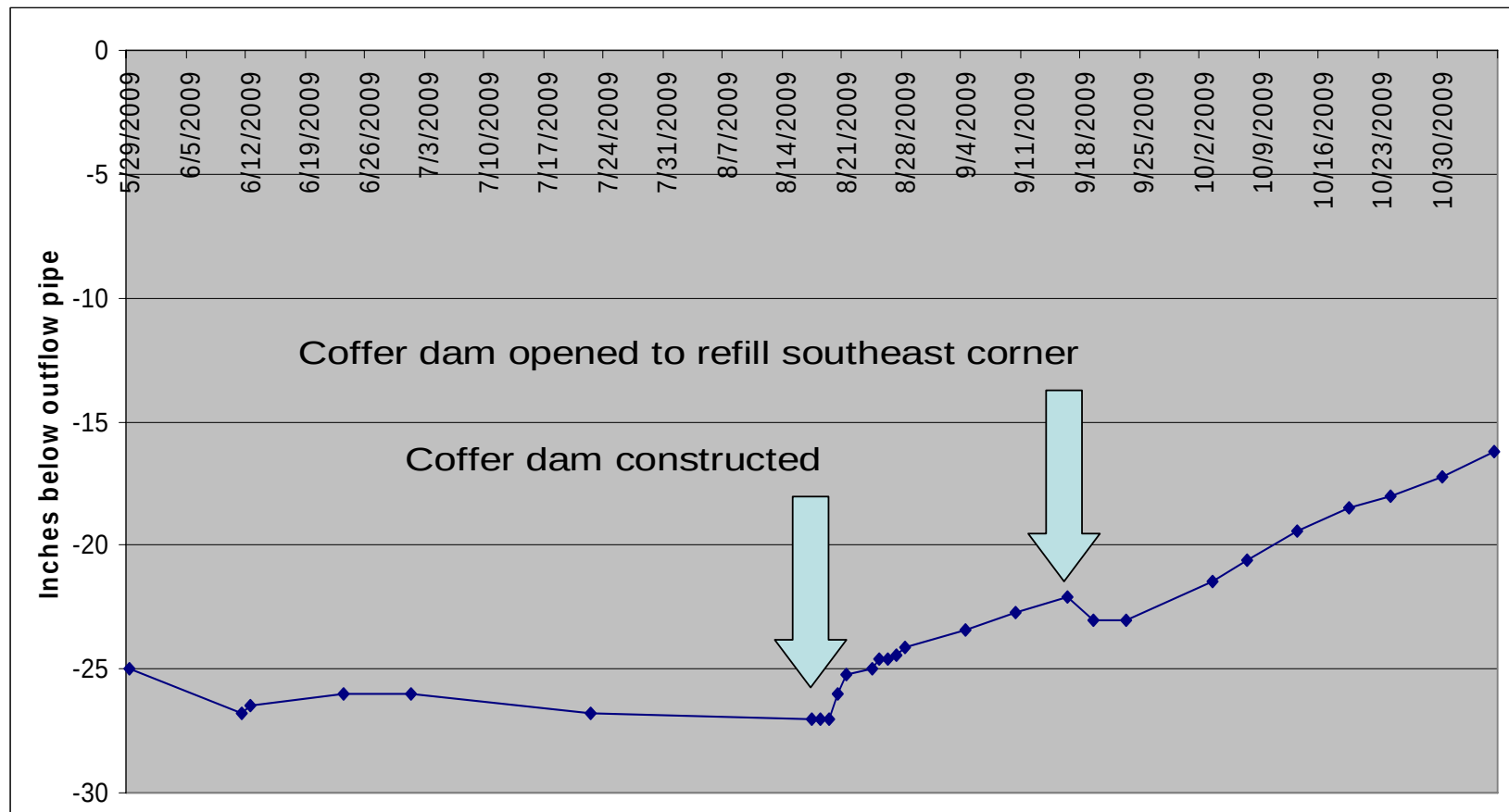


Figure 19. Trend in surface elevation of Quitobaquito Pond, May 29 – November 5, 2009. Rising trend began when the southeast corner was sealed off with a temporary coffer dam August 18. The southeast corner was drained, renovated and re-sealed August 17-28 and was re-filled September 16-19. The coffer dam was removed September 23. Organ Pipe Cactus National Monument, Arizona.

Species Descriptions, Analysis, and Determination of Effects:

Quitobaquito Pupfish

The Quitobaquito (aka Sonoyta) pupfish (*Cyprinodon eremus*) was listed as an endangered species March 31, 1986 (USFWS 1986). That listing of the desert pupfish (*C. macularius*) included the Quitobaquito pupfish as a subspecies of the desert pupfish, *C. m. eremus*. Subsequently, Echelle et al. (2000) examined mitochondrial DNA of the *Cyprinodon macularius* complex, and found pupfish at Quitobaquito and the adjacent Rio Sonoyta to be sufficiently distinct to be considered a unique species, *C. eremus*. The Quitobaquito pupfish (*C. eremus*) is considered to be protected under the original listing of the desert pupfish www.fws.gov/southwest/es/arizona/Documents/Pima.pdf.

The Quitobaquito pupfish inhabits the southwest spring, stream channel, and pond at Quitobaquito in the southwestern portion of Organ Pipe Cactus National Monument, and isolated pools and ephemeral reaches of the Rio Sonoyta in adjacent Mexico. The U.S. Fish and Wildlife Service designated “Quitobaquito Spring . . . and a 100-foot riparian buffer zone around the spring” as critical habitat for this species (USFWS 1986). The NPS considers the critical habitat designation to include the stream channel and pond, in addition to the springs.

Pupfish numbers at Quitobaquito pond, channel, and springs have been monitored over approximately the last 25 years. Monitoring efforts were sporadic prior to 1989, but have been carried out annually since 1989. The current annual census has two primary objectives. The first is to provide information on the status of *C. eremus* in the pond and channel. The second objective is to thoroughly examine and sample the pond and channel for the presence of non-native fish that may detrimentally affect pupfish. Several monitoring protocols have been used over the years. Changes in methods have been the result of the Monument’s continuing desire to minimize impacts on pupfish from trapping and handling, while at the same time applying the most current and/or appropriate methods in population sampling. Based on advice from regional ichthyologists, the Monument’s current approach is to generate general population indices which would alert management to serious population reductions. Intensive sampling methods that would produce highly accurate estimates are deemed inappropriate for the annual monitoring at this time because they tend to be intrusive to pupfish and require a large amount of staff time. Further, the information gained from this venture may be of little management relevance for a species whose life history normally includes substantial fluctuations in population levels. The Monument’s management goal for the Quitobaquito pupfish population is to detect any changes in overall demographics, such as a precipitous drop to extremely low numbers or the absence of reproduction, or changes in the physical environment which might constitute a threat to the population.

Sampling methods have varied over the years, from fin-clipping mark-recapture techniques to a depletion sampling method used by Monument staff 1990-1996. A mark-recapture technique using a temporary fluorescent powder dye was evaluated in the late 1990s (Douglas and Douglas 2000). While all techniques used over the last 25 years have had positive aspects, all have also had drawbacks. Early fin-clipping mark/recapture methods required intensive handling of numerous individual fish. Fin-clipping had the potential to also injure individuals. The depletion sampling method involved holding large numbers of pupfish in holding tanks for over 24 hours, creating conditions for antagonistic interactions. Mortalities resulting from overcrowding were

frequently observed with this method and often approached the level of “incidental take” allowed under the Monument’s USFWS ESA permit. The temporary fluorescent powder dye mark-recapture technique also appeared to stress the fish and presented other logistical difficulties.

Beginning in 2000, the Monument instituted a census modeled after the depletion sampling methods, but revised as an index based on fish trapped per unit of effort. This was undertaken to minimize impacts and stress on pupfish, develop an adequate index of population size, and allow comparison of data with the years when the depletion sampling method was used. This method was carried out from 2000 through 2007. Comparison of the 2000-2007 surveys with previous years is possible, on a basis of numbers of fish trapped per unit of effort. The 2000-2007 method used the same timing (September), number and locations of traps that were established in the depletion sampling protocol of 1992-1996. To compare 2000 through 2007 with those previous years on a basis of fish trapped per unit of effort, we totaled fish caught in each year only for the minimum number of traps used in any one of those years, and for only the first three 2-hour trapping runs in the pond, and first 4-hour trapping run in the channel (Table 1, Figure 20). This comparison was not possible for census activities in 1997 through 1999, because those efforts used numbers and locations of traps, and trapping durations that were not comparable to other years.

In September 2008 and 2009, the pond was too shallow to submerge minnow traps. In addition, bulrush encroachment made possible by the shallow water had displaced open water areas of the pond where standard trap placements were located. As a result, it was not possible to carry out the standard methods used in 2000-2007. A limited survey was done in 2008, sampling only the moat and channel, to compare with capture rates in those areas in previous years (Table 1, Figure 21). In 2009, no sampling was done; all available work time at Quitobaquito was allocated to the southeast corner renovation and related activities.

The Quitobaquito pupfish census is intended to yield a population index, not a precise population estimate. The population index surveys suggest that in 2007, total pupfish numbers were at a high level not documented since 1995 and 1996. Although this survey is intended to be a general index of population size, it usually also allows a rough estimate of the total population. This estimate is based on the total pupfish captures for the survey, plus our subjective observations of the number and distribution of pupfish remaining free at the survey’s end, before the captured fish are released back into the system. In 2007, we estimated the population to be in the range of 8,000 to 12,000 or more, or somewhat in excess of the approximate long-term average of 6,000 to 9,000. In 2008, we estimated the population to be in the range of 5,000 to 7,000 or more, or somewhat below the long-term average. Having no survey data for 2009, a population estimate is approximate at best. Based on continuing loss of habitat in the pond due to reduced water volume, bulrush encroachment, and mortalities due to stranding in mud and bird predation, we suspect the population remaining is likely less than 4,000.

Over the last 30 years, the estimated number of pupfish at Quitobaquito ranged from approximately 3,500 to 15,000. Estimates include: 7,986 in 1975, 3,592 and 4,558 in 1976 (Kynard and Garritt 1979, *in* Miller and Fuiman 1987). Monument depletion sampling efforts in the early 1990s also yielded results in the range of 6,000 – 8,000. Using a mark-recapture census (fluorescent dye method) in 1996-1997, Douglas et al. (2001) estimated the population at 9,556. In 1998, using the Douglas et al (2001) method, the Monument census yielded an estimate of 8,823 fish ($\pm 3,500$). Population extremes are represented by highs in 1995-1996, when a depletion sampling method yielded an estimated population of over 15,000. The 2007 capture rates indicate a total population comparable to 1995 and 1996. Population low points of approximately 3,500 to 5,000 occurred in 1992, 1994, 2005, and 2009.

Table 2. Captures of <i>Cyprinodon eremus</i> at Quitobaquito, by standardized trapping effort. Organ Pipe Cactus National Monument, Arizona, 1992 – 2008.			
	Pond & Moat	Channel	Total
1992	929	504	1,433
1993	2,785	663	3,448
1994	668	604	1,272
1995	3,559	642	4,201
1996	4,619	633	5,252
1997-1999 ¹	-	-	-
2000	1,598	496	2,094
2001	1,678	414	1,992
2002	2,109	377	2,486
2003	2,949	660	3,609
2004	3,301	504	3,805
2005	684	674	1,358
2006	2,211	771	2,982
2007	4,161	1,200	5,361
2008	Moat Only: 747	946	1,692
Average	-	649	-
Mean	-	620	-
Standard Deviation	-	215	-

¹ No census was done in 1997. The 1998 and 1999 censuses used trap numbers, locations, and trap-session durations that were not comparable to other years. “Total” values for 1992-2007 are for 59 traps including 42 pond traps not set in 2008. “Total” for 2008 is for 17 traps, Moat and Channel only.

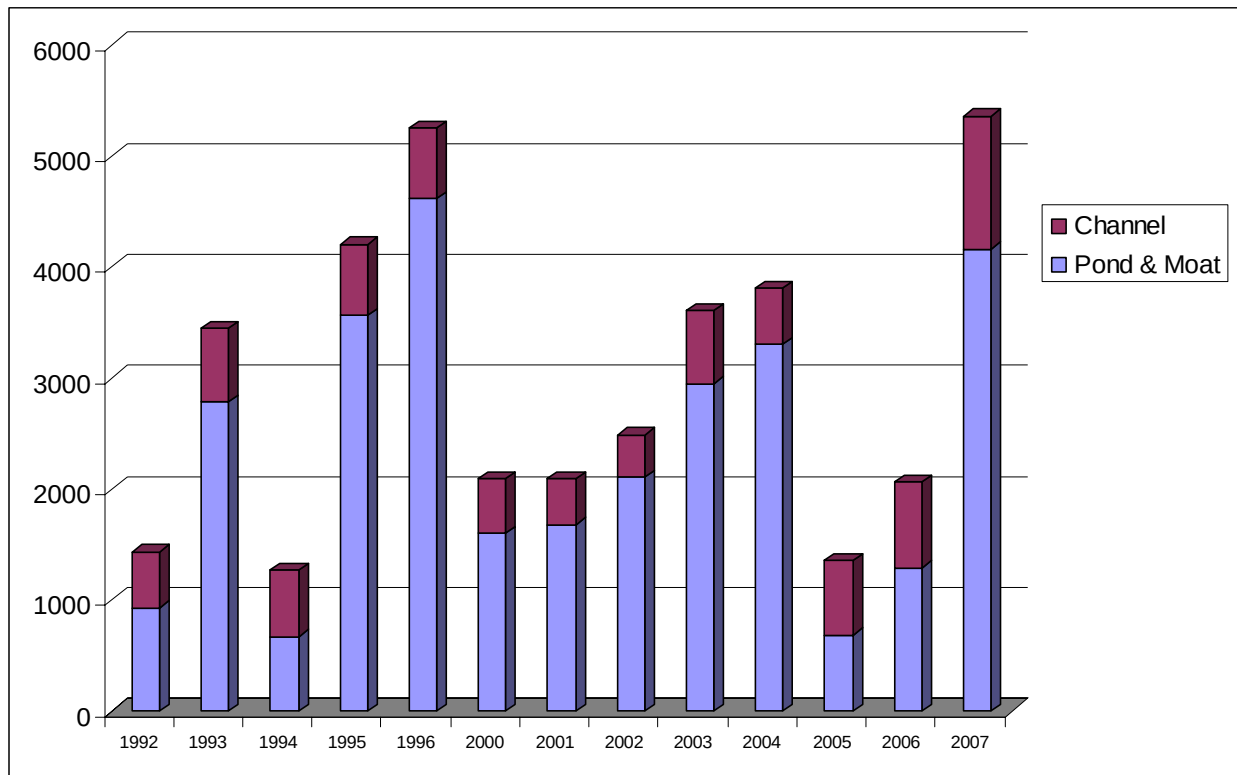


Figure 20. Captures of *Cyprinodon eremus* at Quitobaquito, by standardized trapping effort. Organ Pipe Cactus National Monument, Arizona, 1992 – 2007. No census was done in 1997. The 1998 and 1999 censuses used trap numbers, locations, and trap-session durations that were not comparable to other years.

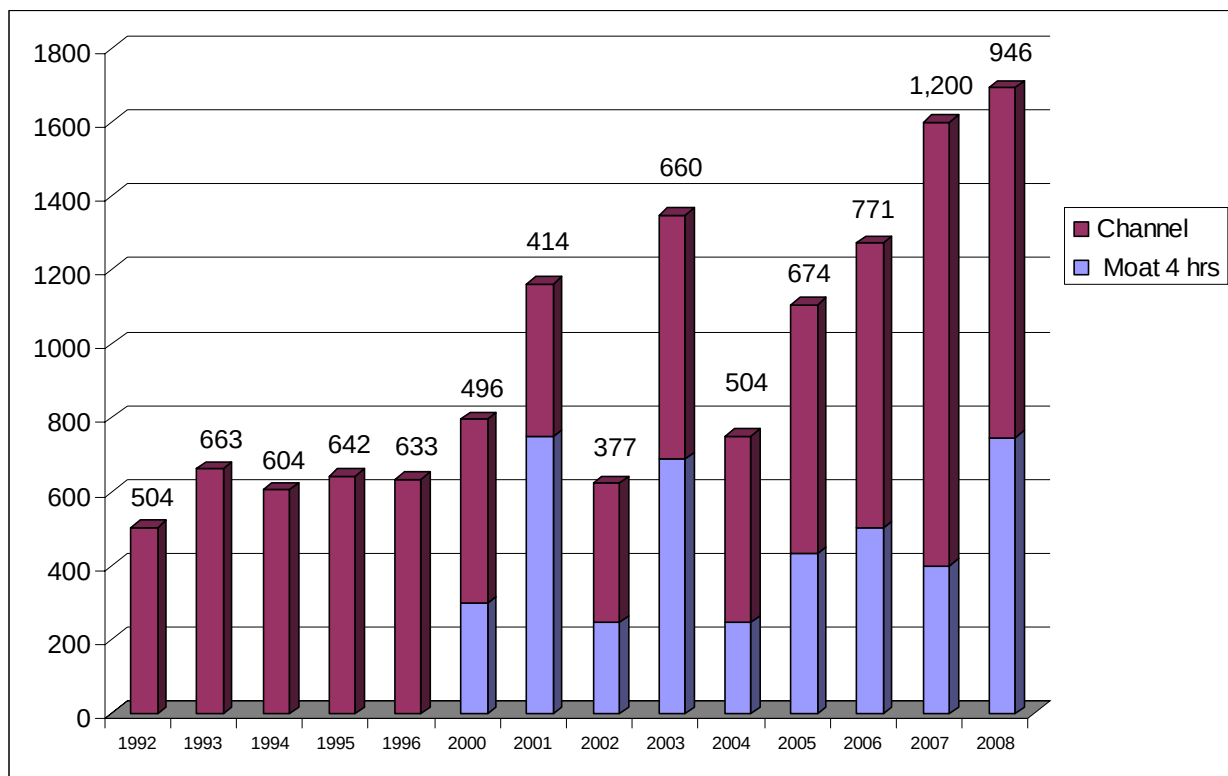


Figure 21. Captures of *Cyprinodon eremus* in the Channel and Moat at Quitobaquito, by adapted standardized trapping effort. Organ Pipe Cactus National Monument, Arizona, 1992 – 2008. No census was done in 1997. The 1998 and 1999 censuses used trap numbers, locations, and trap-session durations that were not comparable to other years. Numerical values above columns are for channel captures only. Moat data prior to 2000 were not used in this comparison.

Analysis of Effects on Quitobaquito (Sonoyta) Pupfish

The proposed action took place within occupied, designated critical habitat for Quitobaquito pupfish. The primary motivation for undertaking this project was to reverse a 4-year trend of progressively degrading conditions and loss of this habitat. To date, ORPI has explored and carried out all reasonable alternative actions that avoided significant activity and disturbance within the aquatic environment at Quitobaquito. Unfortunately, those actions have been ineffective at restoring the system's integrity and stability. To continue attempts to restore Quitobaquito Pond, activity within the pond itself was the only remaining action having some likelihood of success. In the draft project BA, ORPI proposed to approach this activity conservatively. Rather than renovating the entire pond in one large project, we proposed to begin renovation at several localized, highly suspect areas. Three objectives motivated this approach: 1) To disturb as little pupfish habitat and as few pupfish individuals as possible, in the process of effecting a repair; 2) To manipulate and modify as little of the cultural and aesthetic setting as possible; 3) To limit expenditures of resources to only those necessary to effect a repair, rather than undertaking a larger action than may be necessary. Despite this cautious approach, the nature of the proposed action made some incidental take of Quitobaquito pupfish likely. This take was anticipated to be in the form of direct injury or mortality of egg masses and/or individual

pupfish, and harassment. The project included the following measures to avoid, offset, and mitigate for possible take:

1. Avoidance/Evacuation

Installing the temporary coffer dam did not appear to result in take of pupfish, but may resulted in take of pupfish eggs. Pupfish tend to vacate areas where people are wading in the pond. As expected, virtually all pupfish appeared to depart the areas of possible harm: the bulrush stands cleared at the banks to make anchor points for the temporary cofferdam, and the route where the cofferdam was installed. However, any pupfish eggs in these areas would have remained in place, and might have been destroyed by human disturbance.

As described above in the “Description of Emergency Actions,” after the coffer dam was in place, we attempted to evacuate all pupfish from the work area – the southeast corner - prior to undertaking disturbing activities. All possible pupfish were removed from the work area behind the coffer dam. Pupfish were captured by dip net, seine net, and buckets. Captured individuals were immediately relocated to the rest of the pond, by emptying nets and buckets directly over the coffer dam. To reduce stress on pupfish and expedite the evacuation, captured fish were not counted or closely examined. No fish were held for longer than about 2 minutes. An estimated 1,500 pupfish were relocated from the southeast corner into the remaining pond.

While we were confident incidental mortalities could be minimized, we recognized the reality that some were likely. We suggested that our allowable incidental take be temporarily increased to 400 pupfish, for the life of this project. We noted that, as extreme low-water conditions persist in the pond, that many fish may be lost to predation on some single days, as pupfish are rendered vulnerable to predation by piscivorous birds, and even great-tailed grackles.

In the course of evacuating the southeast corner, we counted 82 pupfish mortalities. We suspect some of these were caused by physical trauma, as workers waded through the target area capturing fish. Some of these mortalities also appeared to be caused by suffocation; as the water became turbid from project activity, and thicker as a result of pumping out clear water, some pupfish were found at the water surface gulping for oxygen. With the last few hundred gallons of water remaining in the southeast corner, lying over the mud layer, we observed numerous very small fry ($\leq 10\text{mm}$) coming to the surface of the highly turbid water. Some of these also appeared to be seeking higher oxygen concentration, and better visibility, at the water surface. At that point, we began emptying the last turbid water over the coffer dam into the main pond, by bucket brigade. Our intent was to transfer as many of these small fry as possible, over into the pond. While we succeeded in salvaging hundreds of such fry, it is likely several hundred were also lost to suffocation in the thickening mud layer. Our rough estimate is that possibly 300 pupfish fry mortalities resulted.

2. Offsetting/Mitigating Measures

Several measures have been undertaken to offset adverse effects of the project on pupfish. Many of these actions were taken prior to development of the proposed project. Regardless, these offsetting measures were undertaken in anticipation that something like the project action would inevitably be necessary.

- Cabeza Prieta NWR refuge pond. In 2004, ORPI cooperated with Cabeza Prieta NWR to establish a refuge pond at refuge headquarters in Ajo, Arizona. The US Fish and Wildlife Service constructed a refuge pond with assistance from cooperators. On October 22, 2004, ORPI staff translocated 195 pupfish to the refuge pond.
- “La Cienega” Quitobaquito pupfish refuge pond: This refuge pond was completed in 2005. La Cienega is located at the Kris Eggle Visitor Center at ORPI headquarters. Originally stocked with 235 pupfish translocated from Quitobaquito, the pond soon attained an average population of approximately 600 pupfish. To maintain genetic diversity, 50 additional pupfish were brought from Quitobaquito in mid-2008. By early 2009, ORPI recognized that larger-scale, potentially disruptive work within Quitobaquito Pond would likely be necessary. In response, La Cienega was expanded with the addition of a second pond, connected to the first by a small stream. The new addition was stocked with 218 pupfish in April 2009. As of October 2009, The expanded La Cienega contains approximately 1100 pupfish, with reproduction continuing through all warm months of the year.
- Emergency Evacuations From Quitobaquito: Recognizing the severity of the situation at Quitobaquito, in 2007 and 2008, ORPI evacuated pupfish from Quitobaquito to secure off-site locations. We were greatly assisted in these efforts, by the Arizona Game and Fish Department, US Fish and Wildlife Service, and Arizona-Sonora Desert Museum. The original evacuations are summarized in Table 3. We estimate that as of October 2009, over 3000 Quitobaquito pupfish are held in secure off-site locations. We also estimate the remaining channel, moat, and pond at Quitobaquito hold approximately 3000 to 5000 pupfish, for a total of 6000 to 8000 Quitobaquito pupfish in the US.
- Restoration of Quitobaquito Pond: The ultimate goal of this action was the major factor offsetting impacts on pupfish caused by the action itself. That goal was to restore Quitobaquito Pond to something close to its pre-2005 size and stability. In that condition, Quitobaquito was typically estimated to support an average of 6,000 to 9,000 pupfish. Of that number, 80% or more likely occupied the pond (4,800 to 7,200), with the remainder in the channel. In some high population years, the system contained over 15,000 pupfish. In September 2008, an estimated 2,500 to 4,000 pupfish remained in the pond, with a similar number in the channel/moat system. Since that estimate, bulrush encroachment and persistent low water have further reduced habitat available in the pond. If the trend is not reversed soon through bulrush removal and restoring a higher pond level, Quitobaquito Pond may no longer support more than 1000 pupfish by late 2010. It is conceivable that by midsummer 2011, the pond would exist only as a dense bulrush marsh, with little standing water and low numbers of pupfish persisting in what remains. The proposed action sought to restore Quitobaquito Pond to a condition such that it is capable of supporting at least 5,000 pupfish, with 1,500 to 3,000 remaining in the channel system.

Table 3. Evacuations of Quitobaquito pupfish from Quitobaquito Pond, 2004-2009.			
Date	# Evacuated	Holding Location	Status
10/22/04	195	CPNWR South (original)	Stable, increased over original numbers. Most moved to new pond ("north") in 2006.
4/18/05	159	ORPI La Cienega	Stable; increased to average 600
5/17/05	76	ORPI La Cienega	Stable; increased to average 600 (w/ above)
10/25/07	1,048	Arizona-Sonora Desert Museum	Stable; $\geq 60\%$ of population remains (~600 fish)
04/08/08	668	ORPI Tank #1: 332	24 mortalities over 1 st 75 days, now stable w/ reproduction,
		ORPI La Cienega: 50	Stable; permanent relocation for genetic maintenance
		CPNWR North: 50	Stable; permanent relocation for genetic maintenance
		CPNWR South: 236	Stable
04/15/08	257	ORPI Tank #1: 257	24 mortalities over 1 st 75 days now stable w/ reproduction. 101 fish moved to La Cienega April '09. Reproduction in tank. ~450 currently.
05/07/08	500	ORPI Tank #2: 500	>116 mortalities in 1 st week (thermal shock?) now stable w/ reproduction. 117 fish moved to La Cienega April '09. Reproduction in tank. ~450 currently.
4/14 & 4/29/09	218	Expanded ORPI La Cienega	101 fish moved in from ORPI Tank #1 117 moved in from ORPI Tank #2
Total	2,903	Approx 3,300 October 2009: ORPI Tank #1: 450 ORPI Tank #2: 450 ORPI La Cienega: 1,100 ASDM: 600 CPNWR 700	

Critical Habitat

This project took place within designated critical habitat for the Quitobaquito pupfish. The "constituent elements" of critical habitat are "...clean unpolluted water that is relatively free of exotic organisms, especially exotic fish. . . small, slow-moving desert streams and spring pools with marshy backwater areas . . ." (USFWS 1986). Safeguarding and re-establishing critical habitat for the Quitobaquito pupfish was among the major goals of this project.

Since the low-water issue developed in 2005, pupfish critical habitat constituent elements at Quitobaquito have been altered qualitatively, and reduced quantitatively. The project actions were undertaken primarily to restore the critical habitat constituent elements of Quitobaquito Pond, both qualitatively and quantitatively. If successful, the project may restore the pond to approximately 26,000 to 28,000 square feet surface area, with a depth ranging from about 18" to 42". As of late October 2009, it appears the project was largely successful.

The project caused temporary dewatering of the southeast corner, an area of approximately 4500 ft². This equates to approximately 15% of the total pond area, prior to the low-water situation (29,000 ft²). At the time the project was initiated, approximately 2500 ft² of the southeast corner still provided pupfish habitat, with clear water depth ranging from about 4" to 20". The rest of the southeast corner consisted of dense bulrush stands with little or no interstitial water space useable by pupfish. All constituent elements of critical habitat were removed from the southeastern corner, from approximately August 20 to September 23. To some extent, critical habitat constituent elements were simply relocated from the southeast corner, into the remaining pond. The clear water that was pumped out of the southeast corner raised the remaining pond 0.5", resulting in a direct increase in pupfish critical habitat in the remaining pond. On September 23, the coffer dam barrier between the southeast corner and the main pond body was removed. Quitobaquito pupfish almost immediately occupied the area, now reclaimed as 4500 ft² of open water habitat, with clear water depth ranging from approximately 12" to 22".

As discussed above in "Volume of Fill Placed" this renovation also involved placement of compacted fill material into the pond, thereby potentially reducing the total potential pond volume. However, the volume of bulrush and mud removed from the southeastern corner exceeded the volume of new fill placed in the pond. As a result, the project yielded a minimum net increase in the potential volume of the pond (= potential constituent elements) of approximately 1,370 ft³. Further, as a result of the apparent success of the project, the overall water volume of the pond may be restored to something close to its pre-2005 capacity, which would be nearly double the average water volume of 2007-2009. Also, with a higher and more stable water level apparently establishing, the bulrush encroachment of 2006-2009 can now be realistically removed, with diminished chance of rapid return. This factor alone will reclaim pond volume, and pupfish habitat, on a scale several times that of the fill placed in the southeastern corner.

This project had no effect on critical habitat in the springhead or stream channel.

In conclusion: the southeast corner renovation caused the temporary (34 days) loss of approximately 2500 ft² of critical habitat, ranging in depth from 4" to 20". This "loss" to some extent consisted of relocating (increasing) critical habitat in the remaining pond, as water pumped from the renovation area raised the remaining pond level by 0.5". This project also resulted in a net increase in critical habitat in the southeast corner, from about 2500 ft² on August 17 to 4500 ft² on September 23. More significantly, as of November 5, the project appears to have resulted in raising Quitobaquito Pond more than 10". With the pond currently at approximately 24,000 ft² surface area, that constitutes an increase in clear-water critical habitat of approximately 19,920 ft³. If the rising pond trend continues, without triggering another rapid loss of water, the net results of this project will be far more significant. It will have prevented the imminent loss of over 90% of functional critical habitat in Quitobaquito Pond, and will have restored the pond to something close to its pre-2006 condition.

Determination of Effects on Quitobaquito Pupfish:

The project actions *adversely affected* the Quitobaquito pupfish, by resulting in incidental take of at least 82 adult pupfish and possibly up to approximately 300 pupfish fry. An unknown number of pupfish eggs may also have been harmed during project activities.

This project was undertaken primarily to yield beneficial effects for the Quitobaquito pupfish, by restoring Quitobaquito Pond to a relatively stable aquatic system, capable of supporting at least 5000 pupfish. If successful, the proposed project should not only more than double the system's current (2008-2009) carrying capacity for Quitobaquito pupfish, but it will prevent the near-complete loss of the pond that will result within about 18 months, if major actions are not taken. As of late October 2009, it appears the project was largely successful.

The proposed project *did not adversely modify* critical habitat currently existing for the Quitobaquito pupfish. Approximately 2500 ft² of functioning critical habitat were temporarily removed, or relocated, for a 34-day period. Pupfish then reoccupied that area, after its available area had been reclaimed to approximately 4500 ft². If successful, the proposed project should not only reclaim critical habitat that has been lost over the preceding 3 years, but it will prevent the near-complete loss of the critical habitat constituent elements that will result within about 18 months if major actions are not taken.

Sonoran pronghorn

The Sonoran pronghorn (*Antilocapra americana sonoriensis*) was listed as an endangered species March 11, 1967 (USFWS 1967). Critical habitat has not been designated for the Sonoran pronghorn. The Sonoran pronghorn inhabits broad alluvial desert valleys, bajadas, and to a lesser extent foothills areas in southwestern Arizona and northwestern Sonora (Hoffmeister 1986, USFWS 1998). Like other subspecies of the American pronghorn, they prefer open country with expansive views (USFWS 1998). Flat valleys and isolated hills are used more than other topographic features such as mountain slopes (AGFD 1985). The Sonoran pronghorn is found in the Lower Colorado River Valley and Arizona Uplands subdivisions of Sonoran Desertscrub (Brown 1982). The Sonoran pronghorn tends to inhabit relatively open expressions of these associations. However, seasonal shifts in habitat use take place. In general, Sonoran pronghorn tend to occupy valley floor areas in winter (Lower Colorado River Valley subdivision), then move upslope (and southeastward) onto bajadas in spring and summer, into Arizona Uplands subdivision habitats (Wright and deVos 1986, Hervert et al. 1996). The valley floors used in winter tend to be open habitats of creosote-bursage associations with some perennial grasses, and some winter annual plants providing additional forage. Trees such as palo verde (*Parkinsonia* spp.), ironwood (*Olneya tesota*) and mesquite (*Prosopis* sp.) are present primarily along dry watercourses, and are used for thermal cover. As the annual spring dry season progresses, pronghorn move eastward and upslope into the

comparatively more dense and diverse Arizona Uplands association. It is likely that by making this seasonal movement, pronghorn may be able to access more forage plants that have substantial water content, and also escape a few degrees of heat by gaining altitude and greater access to thermal cover. However, pronghorn may be more vulnerable to predators in this more complex, densely vegetated summer habitat.

The U.S. population of Sonoran pronghorn has recovered only tenuously from 2002, when the population was reduced to approximately 21 to 25 animals (Bright and Hervert 2003). Severe drought and widespread illegal border-related activity were likely factors in the decline to that low. The population had increased to approximately 58 in 2004 (Bright and Hervert 2005), likely due to slightly improved rainfall and intensive management activities. The 2008 range wide survey resulted in an estimate of approximately 68 pronghorn (J. Bright, AGFD and J. Atkinson, USFWS, in lit.). This estimate was lower than anticipated and is likely a result of continuing drought conditions, and continuing border-related activities (e.g. off-road vehicle traffic).

Sonoran pronghorn are susceptible to disturbance by human activities on the ground (USFWS 1998, 2001). Human activities may cause pronghorn to avoid or move away from the area. This may adversely affect pronghorn by denying them access to important habitat resources, and/or by incurring the physiological costs of moving away.

Although Sonoran pronghorn range across much of the western two-thirds of the monument, they have never been reported in the project area at Quitobaquito. Radio telemetry monitoring carried out by the Arizona Game and Fish Department 1994-2002 and 2006-2009 did not result in any detections of Sonoran pronghorn within several miles of Quitobaquito (Hervert et al. 2000 and AGFD unpubl. data). Dickson and Tidbits (1998) used motion-triggered cameras to investigate pronghorn use of Quitobaquito, but recorded no visits by pronghorn. Similarly, of all casual observations of Sonoran pronghorn in monument files from 1945 to the present, none are from Quitobaquito or nearby (Organ Pipe Cactus National Monument files). The availability of water at Quitobaquito may suggest pronghorn should be expected to visit the area. However, the current high level of human activity and highway noise adjacent to Quitobaquito in Mexico makes their absence easier to understand. The dense thickets of vegetation around Quitobaquito may also deter pronghorn from visiting the site.

Analysis of Effects on Sonoran Pronghorn

This project took place in an area where available information indicates Sonoran pronghorn occur rarely or never. The project was carried out using motorized equipment, including pumps, backhoe, smaller tractor, and trucks. The sounds of that equipment and the manual labor of the project were likely masked by the sound of truck traffic on Highway 2 nearby in Mexico. Project activities were relatively quiet and non-intrusive by comparison.

Determination of Effects on Sonoran Pronghorn

The proposed action had *no effect* on the Sonoran pronghorn.

Lesser long-nosed bat

The lesser long-nosed bat (*Leptonycteris curasoae yerbabuena*) is a nectar, pollen, and fruit-eating species that migrates seasonally from Mexico to summer in southern Arizona and southwestern New Mexico (Hoffmeister 1986, USFWS 1997). This species was listed as endangered in 1988 (U.S. Fish and Wildlife Service 1988). A recovery plan was finalized in 1997 (USFWS 1997). No critical habitat has been proposed or designated.

Organ Pipe Cactus NM contains the largest known maternity colony of the lesser long-nosed bat in the United States. The colony was established by 1969 (Pat Brown, in lit.) and has a current estimated base colony size of 25,000 to 35,000 adult female bats. The bats use an abandoned mine tunnel which passes completely through Copper Mountain. Adult female bats begin arriving in mid-April of each year. In mid to late June, young begin flying and contribute to the nightly emergence flight. The colony usually reaches its peak size in late June and early July, when most adult females and their offspring are present. In July and August numbers decrease, as adults and young disperse to other local roosts and/or move eastward and to higher elevations to feed on agaves. Most bats are typically gone from the Copper Mountain colony by late September.

The lesser long-nosed bat is likely to forage throughout the monument, wherever saguaro and organ pipe cacti are present (Organ Pipe Cactus National Monument 2006a and b). That is, the species probably forages on all middle-to-upper bajada areas, and throughout all the mountain ranges. The lesser long-nosed bat may also travel over valley-bottom areas where columnar cacti are rare or absent, as it forages over wide areas. The foodplants of the lesser long-nosed bat, are present in the Quitobaquito area. This bat has rarely been captured at Quitobaquito during the monument's bat monitoring program (Organ Pipe Cactus National Monument 2006a), but is suspected to forage in the immediate vicinity.

Analysis of Effects on Lesser Long-nosed Bat:

The proposed project took place in August, during the time of year when the lesser long-nosed bat is present in the area (Organ Pipe Cactus National Monument 2006b). The project took place only during daylight hours, when bats would be in day-roosts. The project did not take place near any known roosts for this bat. The large maternity roost in the monument is approximately 18 miles from the project area, and should not have been affected by project activities. Finally, the proposed project did not damage or remove any foodplants for the lesser long-nosed bat.

Determination of Effects on Lesser Long-nosed Bat

The project actions had *no effect* on the lesser long-nosed bat.

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This project was successfully completed only because of the hard work, dedication, and cooperation of the entire staff of Organ Pipe Cactus National Monument. Critical assistance was also provided by the Arizona Game and Fish Department and the US Fish and Wildlife Service. The project was carried out in late August; afternoon high temperatures exceeded 104° F on all days and exceeded 110° F on the last 3 days of the project. There were no on-the-job staff injuries, and the project was completed within budget. Please see Appendix I for a list of project personnel.

Appendix I

Quitobaquito Pond, Southeast Corner Renovation - Personnel

Organ Pipe Cactus National Monument

Hunter Bailey	Security
Lee Baiza	Planning, Preparation
Daren Belskis	Security
Mikel Bengé	Worker
Bob Bryant	Planning, Preparation, Equipment Operator, Worker
Alex Bustamante	Preparation
Charles Conner	Worker
Janet Kellogg	Facilitation, Acquisitions
Caleb Kesler	Security
Connie Gibson	Cultural compliance
Kyle Greene	Worker, Security
Mitch Hauptman	Worker, Security
Connie Herrera	Facilitation, Acquisitions
Peter Holm	Worker, Project preparation
Sarah Howard	Worker
Steve Howard	Worker
Ann Huston	Worker
Andy Martin	Preparation
Christine Moscatiello	Facilitation
Ami Pate	Planning, Preparation, Worker, Captive pupfish care
Ernie Rheäume	Worker
Kenny Richardson	Planning, Preparation, Equipment Operator, Mechanic, Worker
Sue Rutman	Preparation
Dustin Riordan	Worker
Frank Sanora	Equipment Operator, Worker
Daniel Simon	Worker
Mark Sturm	Planning, Preparation, Worker
Dane Tantay	Security
Matthew Thornton	Worker
Tim Tibbitts	Planning, Preparation, Worker, Project lead
Mark Wozniak	Worker, Security

Additional ORPI law enforcement staff and the NPS Intermountain Region Special Event Tactical Team provided site security.

Other National Park Service Offices

Elizabeth Baierl	Contracting
Colleen Filippone	Consultation
Larry Martin	Consultation

Arizona Game and Fish Department

Yvonne Anderson	Turtle evacuation/transport
Cristina Jones	Consultation, Turtle evacuation/transport
G.M. Merrill	Consultation
Ross Timmons	Consultation
Bruce Weise	Turtle evacuation/transport
Erin Zylstra	Turtle evacuation/transport

US Fish and Wildlife Service

Doug Duncan	Consultation
Erin Fernandez	Consultation
Jim Rorabaugh	Consultation

Arizona-Sonora Desert Museum

Stéphane Poulin	Pupfish and turtle holding
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