



Reconstructing the Water Level Record at MC Spring since 1990

Mojave National Preserve

Natural Resource Report NPS/MOJN/NRR—2015/1006



ON THE COVER

Photograph of the old staff gage at MC Spring.
Photograph courtesy of Steve Parmenter.

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Abstract

MC Spring is located on the edge of Mojave National Preserve (MOJA) near the Desert Studies Center at Zzyzx. The spring is one of a handful of refugia for the endangered Mohave tui chub (*Siphateles bicolor mohavensis*) and represents an important aquatic resource for the preserve.

In June 2013, the Mojave Desert Network Inventory and Monitoring Program (MOJN I&M) installed a new staff gage and pressure transducer to monitor water level in the spring as part of the MOJN I&M Selected Large Springs protocol. At the same time, we removed an old staff gage that had been in the spring since before 1986. The old staff gage was a length of 3/4-inch PVC pipe that had markings painted on it at regular intervals. These markings faded into distinctive patterns over time. Photographs that show the old staff gage can be used to estimate historical water levels and tie them into the modern record.

The data obtained from 21 photographs taken between 1990 and 2013 show that the water level in the spring varied by at least 1.25 feet over that time. The highest stage (6.65 feet) was observed in a photo from May 1990, while the lowest stage (5.40 feet) was observed in a photo from May 2010. Comparing these stages with the readings from the new staff gage and pressure transducer indicates that recent water levels are within the historical norms.

Acknowledgments

The authors would like to thank the people who provided photographs for this study: Robert Fulton (California State University Desert Studies Center), Sujan Henkanaththege (Longwood University), Barry Hibbs (California State University Los Angeles), Debra Hughson and Annie Kearns (Mojave National Preserve), Erin McDonald (MOJN I&M), Steve Parmenter (California Department of Fish and Wildlife), and Allan Schoenherr (Fullerton College). Danette Woo (Mojave National Preserve), Debra Hughson, Judy Hohman (Fish and Wildlife Service), and Steve Parmenter provided assistance in planning and compliance for the installation of the new staff gage.

Introduction

MC Spring is located in northwestern Mojave National Preserve (MOJA) along the western shore of Soda Dry Lake (Figure 1). The site has been occupied for a variety of purposes since the 1860s and has served as an Army outpost, evaporite mining operation, and health resort. California State University now manages the Desert Studies Center at Zzyzx as a field station for education and research.

MC Spring is a limnocrone spring with no outlet. The entire discharge is consumed by evapotranspiration. Vegetation is removed periodically to maintain the pond as an open-water fish habitat. Woo and Hughson (2003) state: “The fact that cattails and sedges in MC Spring must be cut back about every 18 months or so suggests that the existence of this open pool of water, with a surface area of 250 square feet [23.2 square meters] and a volume of 1,000 cubic feet [28.3 cubic meters], is anthropogenic.”

The Mohave tui chub (*Siphateles bicolor mohavensis*, formerly *Gila bicolor mohavensis*) is an endangered fish found in MC Spring. It is a member of the minnow family (Family *Cyprinidae*) and feeds on insect larvae, detritus, and smaller fish (USFWS 2009). The Mohave tui chub is the only fish native to the Mojave River basin and was once widespread throughout the pluvial lakes of the Pleistocene. During the 1930s trout fishermen introduced Arroyo chubs (*Gila orcutti*) as baitfish into Mojave River headwaters. The Arroyo chubs soon spread and hybridized with the Mohave tui chubs (Hubbs and Miller 1943). The USFWS (1984) estimates that by 1970 there were no longer any genetically pure Mohave tui chubs in the Mojave River. Reservoir construction and groundwater extraction in the early twentieth century altered natural flow regimes throughout the Mojave River basin and encouraged colonization by exotic and invasive species. Pollution degraded water quality and also contributed to the decline in Mohave tui chubs (USFWS 1984).

A relict population of genetically pure Mohave tui chubs persists in MC Spring. This population may have been introduced anthropogenically, or it may have arrived naturally in one of the periodic floods that fill Soda Lake to a depth of several meters. The earliest recorded observation of Mohave tui chubs in MC Spring dates back to 1917 (USFWS 1984), and according to the most recent estimate from 2009, there are approximately 495 fish in the spring (Henkanaththegedara 2012).

The National Park Service (NPS) Mojave Desert Network Inventory and Monitoring Program (MOJN I&M) is developing a protocol to monitor the hydrology and ecology of large springs in the MOJN parks. The MOJN Selected Large Springs (SLS) protocol will cover springs in Death Valley National Park (DEVA), Great Basin National Park (GRBA), Joshua Tree National Park (JOTR), Lake Mead National Recreation Area (LAKE), Mojave National Preserve (MOJA), and Grand Canyon-Parashant National Monument (PARA). The monitored springs have been selected in cooperation with park staff to address the parks' resource management priorities. As part of the SLS protocol, MOJN will monitor the water level in MC Spring. The historical data in this report will provide context for the interpretation of the monitoring results.

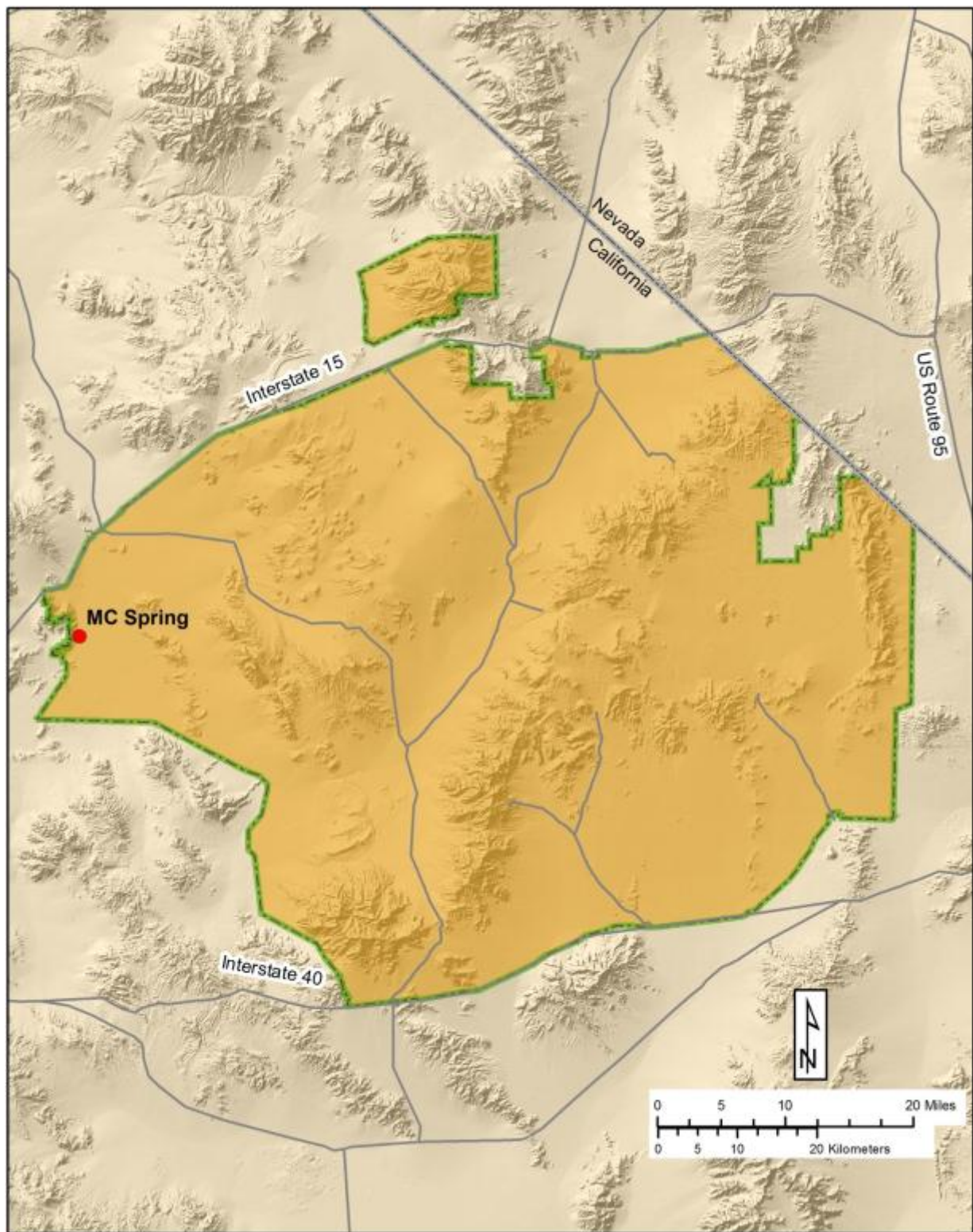


Figure 1. Location of MC Spring in Mojave National Preserve.

Methods

Current Monitoring

MOJN I&M installed a new staff gage at MC Spring on June 25, 2013 (Figure 2). The staff gage is read in feet, and the zero level is approximately 3.0 feet below the bottom of the pool. A vented pressure transducer records the pool stage once an hour. The elevation of the staff gage is surveyed relative to fixed benchmarks once a year to ensure that the record is not interrupted if the gage shifts or requires replacement.



Figure 2. New MOJN I&M staff gage. Left: Staff gage prior to installation. Right: Staff gage on January 15, 2014.

Historical Reconstruction



Figure 3. The old MC Spring staff gage next to a measuring tape displaying the equivalent readings on the new staff gage.

At the same time the new staff gage was installed, an old staff gage was removed from MC Spring (Figure 3). This old staff gage was a piece of $\frac{3}{4}$ -inch PVC pipe that had been installed sometime between 1982 and 1986 (R. Fulton, personal communication). The staff gage was originally marked in decimeters, but additional markings were added and then faded into distinctive patterns over time.

The water level at the time the old staff gage was removed (the top of the blue tape in Figure 3) was read as 6.14 feet on the new staff gage, so photographs showing markings on the old staff gage can be used to estimate water levels that are tied to the current record. Figures 4 and 5 show two examples of how dated photographs were used to estimate historic water levels.

We were able to obtain 21 dated photographs where the old staff gage was shown clearly enough to estimate the water level in the spring. For most photos, we estimate that the uncertainty in the water level estimates is

approximately ± 0.05 feet. When the marking cannot be seen clearly, the uncertainty is approximately ± 0.10 feet.



Figure 4. Top: MC Spring in May 1990. Photograph courtesy of Robert Fulton. Bottom: Digitally zoomed-in version of the photograph compared to the old staff gage. The estimated water level for this photograph is 6.65 ± 0.05 feet.

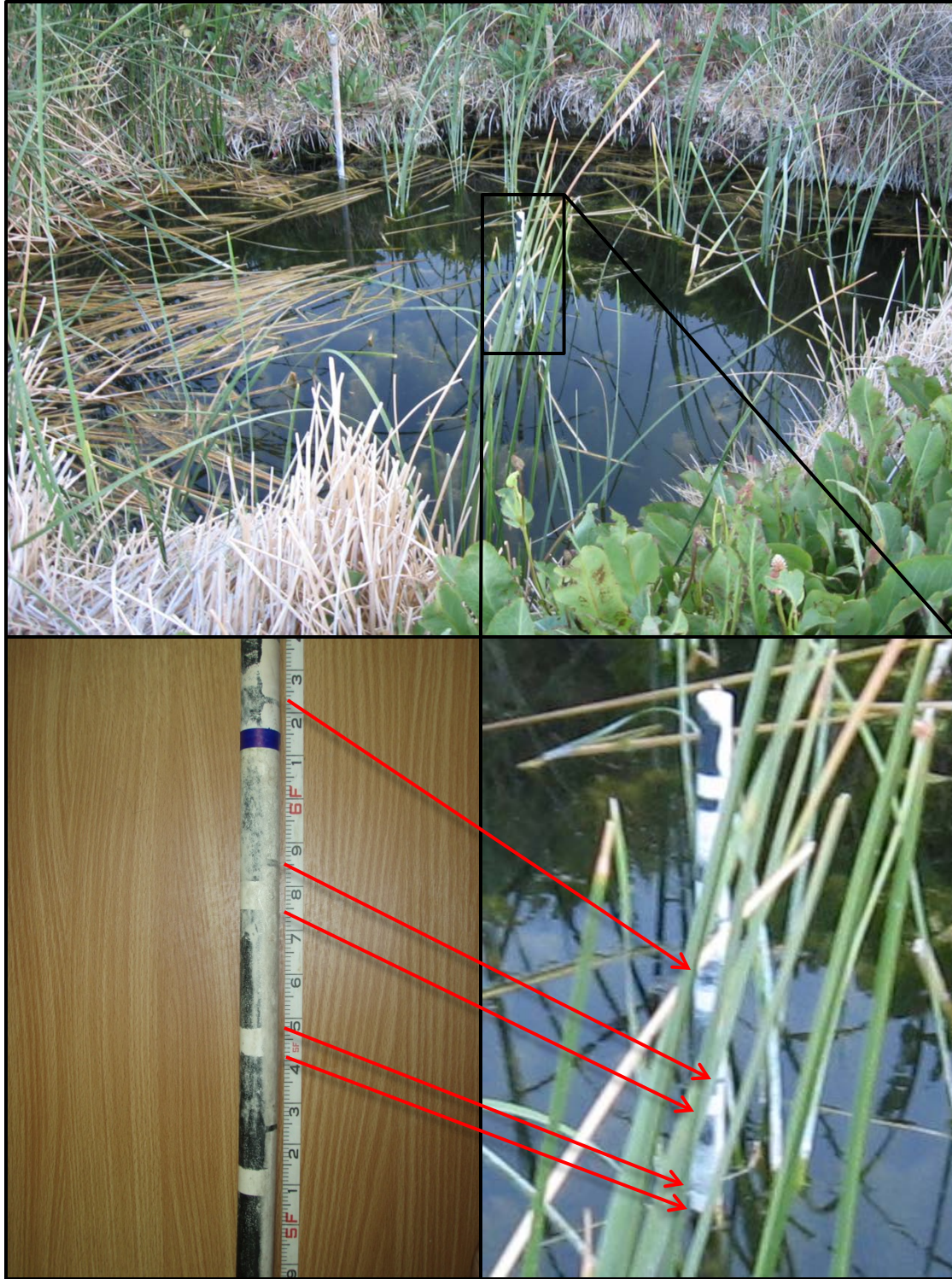


Figure 5. Top: MC Spring in May 2010. Photograph courtesy of Erin McDonald. Bottom: Digitally zoomed-in version of the photograph compared to the old staff gage. The estimated water level for this photograph is 5.40 ± 0.05 feet.

Results

Current Monitoring

Figure 6 shows the staff gage and pressure transducer record for MC Spring from the time of installation through the end of 2014. Due to equipment failures, no reliable pressure transducer data were collected until January 15, 2014. The water level generally increased, particularly from March 2014 to September 2014. At least part of this increase can likely be attributed to two discrete causes:

- On May 15, 2014, the cattails near the outlet of the spring pool were cutback to provide easier access for wildlife. This removal increased the water level by approximately 0.02 feet.
- A series of summer storms occurred in the region from late July to early September. The water level increased by approximately 0.10 feet over this time period.

The monitoring data in Figure 6 do not exhibit the seasonal variation caused by changes in evapotranspiration seen in some other springs.

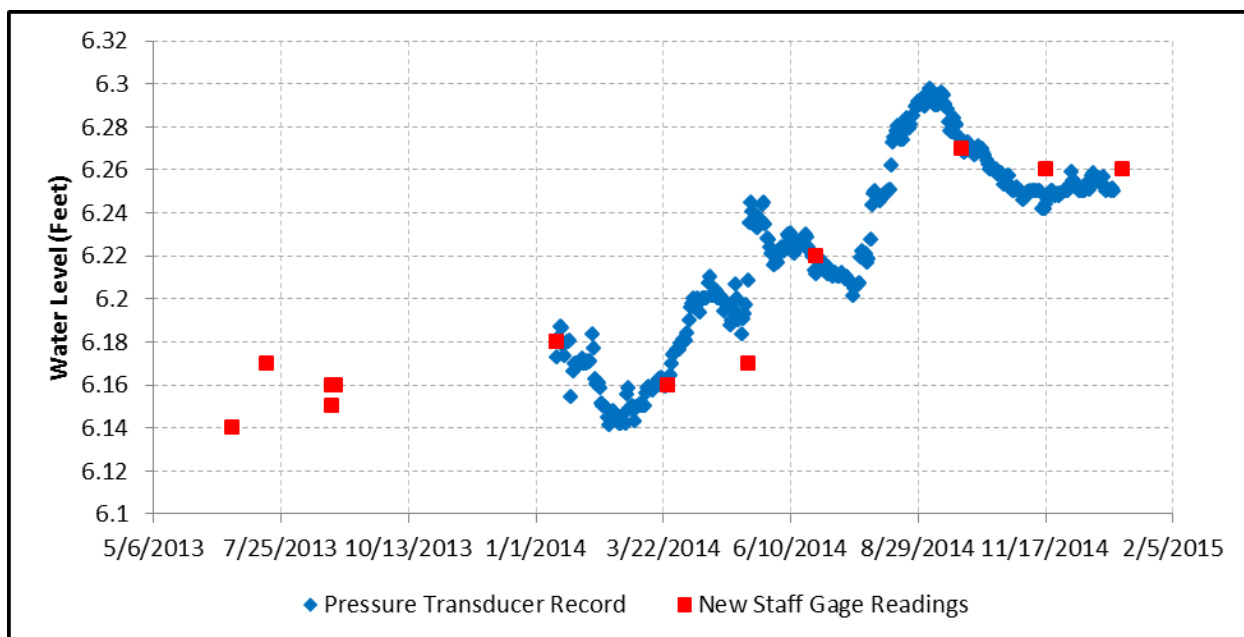


Figure 6. MC Spring water level record from the new MOJN I&M staff gage and pressure transducer.

Historical Reconstruction

Table 1 shows the historical water level estimates derived from available photographs. The highest observed stage is 6.65 feet from May 1990 (Figure 4), while the lowest observed stage is 5.40 feet from May 2010 (Figure 5). The data from these photographs imply that the historical range of variability in MC Spring water level is at least 1.25 feet and that the modern instrument record is well within historical norms (Figure 7). All 21 photographs are included in Appendix A.

Table 1. Water level estimates from dated photographs.

Date	Water Level Estimate (ft)	Error (ft)	Source
May-1990	6.65	±0.05	Robert Fulton
22-May-2002	6.25	±0.05	Steve Parmenter
04-Feb-2003	6.15	±0.05	Mojave National Preserve
03-Sep-2003	6.00	±0.05	Mojave National Preserve
Mar-2005	6.10	±0.05	Barry Hibbs
Nov-2006	6.25	±0.05	Peggy Barthel
22-Jan-07	6.20	±0.05	Sujan Henkanaththegedara
23-Mar-07	6.20	±0.05	Sujan Henkanaththegedara
Jul-2007	6.40	±0.05	Peggy Barthel
2008	5.95	±0.10	Allan Schoenherr
5-Jan-08	6.00	±0.05	Sujan Henkanaththegedara
31-Jan-08	6.20	±0.05	Sujan Henkanaththegedara
12-Feb-08	6.20	±0.05	Sujan Henkanaththegedara
19-Mar-08	6.25	±0.10	Sujan Henkanaththegedara
26-Apr-08	5.80	±0.05	Sujan Henkanaththegedara
5-Sep-2009	5.70	±0.05	Steve Parmenter
7-Jan-2010	5.70	±0.05	Steve Parmenter
24-May-2010	5.40	±0.05	Erin McDonald
21-Nov-2010	5.85	±0.05	Steve Parmenter
18-Dec-2011	6.00	±0.05	Steve Parmenter
24-Jan-2013	6.10	±0.05	Steve Parmenter

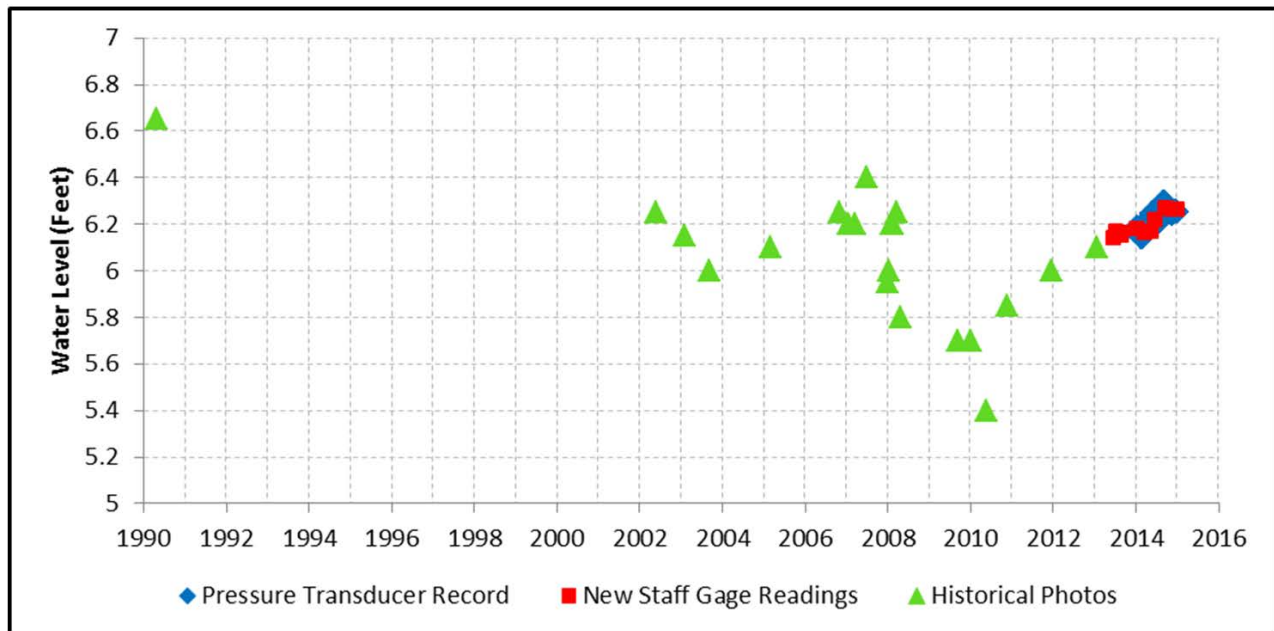


Figure 7. MC Spring water level record from historical photos and the new MOJN I&M staff gage and pressure transducer.

Discussion

The reconstructed water level record for MC Spring shows a range of variability of 1.25 feet. This result provides important context for the current monitoring data—neither recent water levels nor the observed rate of increase are outside of historical norms. Additional photos from the 1980s and 1990s would be useful for assessing the significance of the decline in water level from 1990 to the present day.

The water level of MC Spring is controlled by water inputs (spring flow as well as direct precipitation and runoff), water outputs (evapotranspiration and flow over the outlet), and the elevation and/or partial obstruction of the outlet. The current monitoring data suggest that the water level responds to active management of spring vegetation and to summer rain storms. As more data is collected, it may be possible to determine which factors are responsible for the inter-annual variability seen in the reconstructed record.

Literature Cited

- Barthel, P. 2008. Water budget and hydrogeologic model of spring flow at Limestone Hill, Zzyzx Desert Studies Center. Thesis. California State University, Fullerton, California. Available from <http://www.nps.gov/moja/naturescience/upload/Barthelthesis.pdf>.
- Henkanaththegedara, S. M. 2012. Ecological complexity of non-native species impacts in desert aquatic systems. Dissertation. North Dakota State University, Fargo, North Dakota. Available from http://www.nps.gov/moja/learn/nature/upload/Henkanaththegedara_Ph-D-dissertation_March-2012_v2.pdf.
- Hubbs, C. L., and R. R. Miller. 1943. Mass hybridization between two genera of cyprinid fishes in the Mohave Desert, California. Papers of the Michigan Academy of Science, Arts, and Letters, Volume 28. Available from <http://www.nativefishlab.net/library/textpdf/14281.pdf>.
- United States Fish and Wildlife Service (USFWS). 1984. Recovery plan for the Mohave tui chub, *Gila bicolor mohavensis*. United States Fish and Wildlife Service, Portland, Oregon. Available from http://www.dmg.gov/documents/PLN_Rcvry_MTC_Gila_bicolor_mohavensis_USFWS_091784.pdf.
- United States Fish and Wildlife Service (USFWS). 2009. Mohave tui chub (*Gila bicolor mohavensis* = *Siphaletes bicolor mohavensis*) 5-year review: Summary and evaluation. United States Fish and Wildlife Service, Ventura Fish and Wildlife Office, Ventura, California. Available from http://ecos.fws.gov/docs/five_year_review/doc2392.pdf.
- Woo, D., and D. Hughson. 2003. Zzyzx mineral springs-cultural treasure and endangered species aquarium. George Wright Society Conference. San Diego, California. Available from <http://www.georgewright.org/0320woo.pdf>.

Appendix A: Staff Gage Photographs

This appendix contains all 21 photographs of the old staff gage at MC Spring that were used to reconstruct the water level record. Dates and sources are included in the captions.



Figure A-1. Robert Fulton, May 1990.



Figure A-2. Steve Parmenter, May 22, 2002.



Figure A-3. Mojave National Preserve, February 4, 2003.



Figure A-4. Mojave National Preserve, September 3, 2003.



Figure A-5. Barry Hibbs, March 2005.



Figure A-6. Peggy Barthel thesis, November 2006.



Figure A-7. Sujan Henkanaththegedara, January 22, 2007.



Figure A-8. Sujan Henkanaththegedara, March 23, 2007.



Figure A-9. Peggy Barthel thesis, July 2007.



Figure A-10. Allen Schoenherr, 2008.



Figure A-11. Sujan Henkanaththegedara, January 5, 2008.

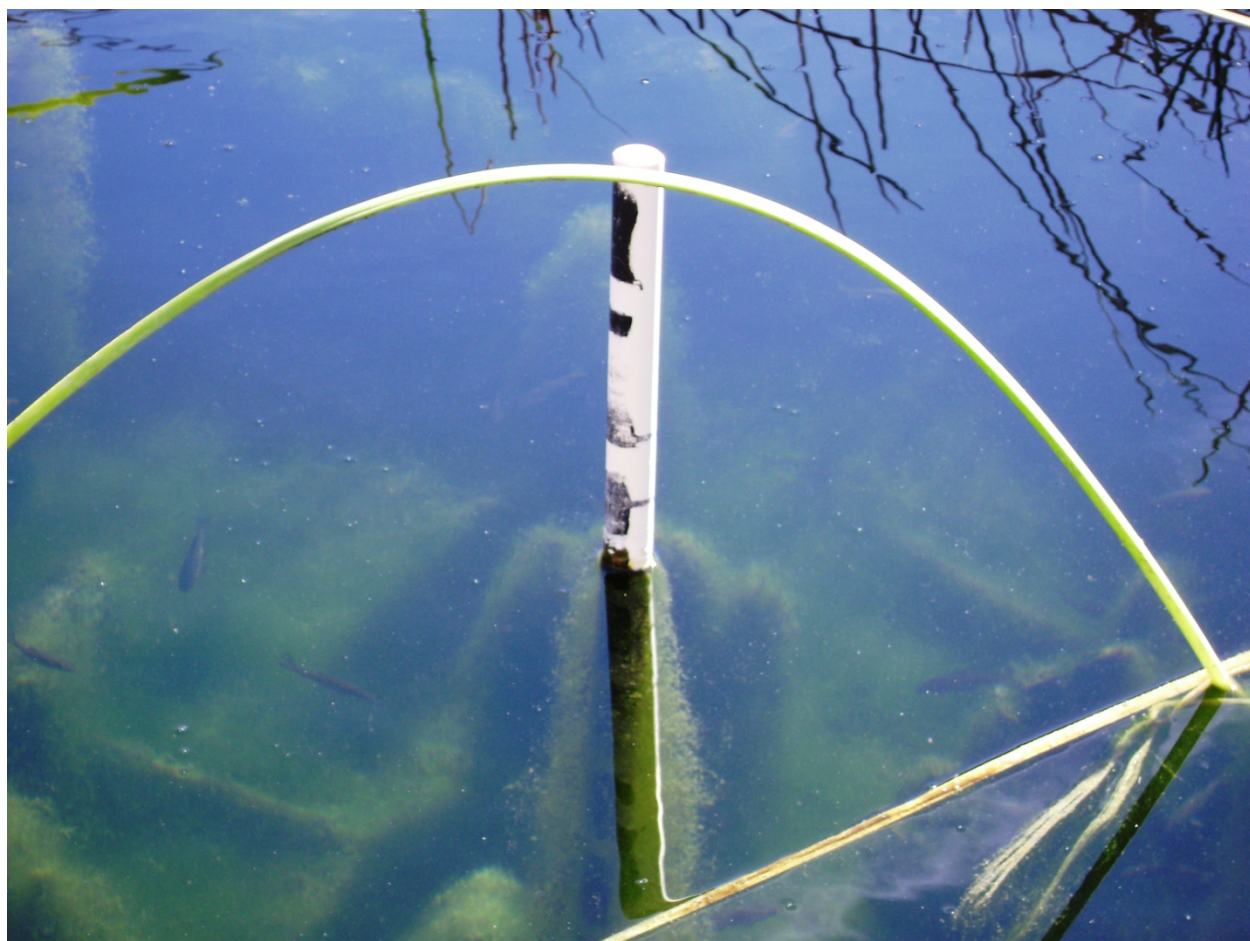


Figure A-12. Sujan Henkanaththegedara, January 31, 2008.



Figure A-13. Sujan Henkanaththegedara, February 12, 2008.



Figure A-14. Sujan Henkanaththegedara, March 19, 2008.



Figure A-15. Sujan Henkanaththegedara, April 26, 2008.



Figure A-16. Steve Parmenter, September 5, 2009.



Figure A-17. Steve Parmenter, January 7, 2010.



Figure A-18. Erin McDonald, May 24, 2010.



Figure A-19. Steve Parmenter, November 21, 2010.



Figure A-20. Steve Parmenter, December 18, 2011.



Figure A-21. Steve Parmenter, January 24, 2013.

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