



# Mojave Desert Network Selected Large Springs Pilot Study

## *Joshua Tree National Park 2014 Data Report*

Natural Resource Data Series NPS/MOJN/NRDS—2015/794



**ON THE COVER**

Fan palms at Fortynine Palms Oasis  
Photograph courtesy of MOJN I&M

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## Overview

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 I&M 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.

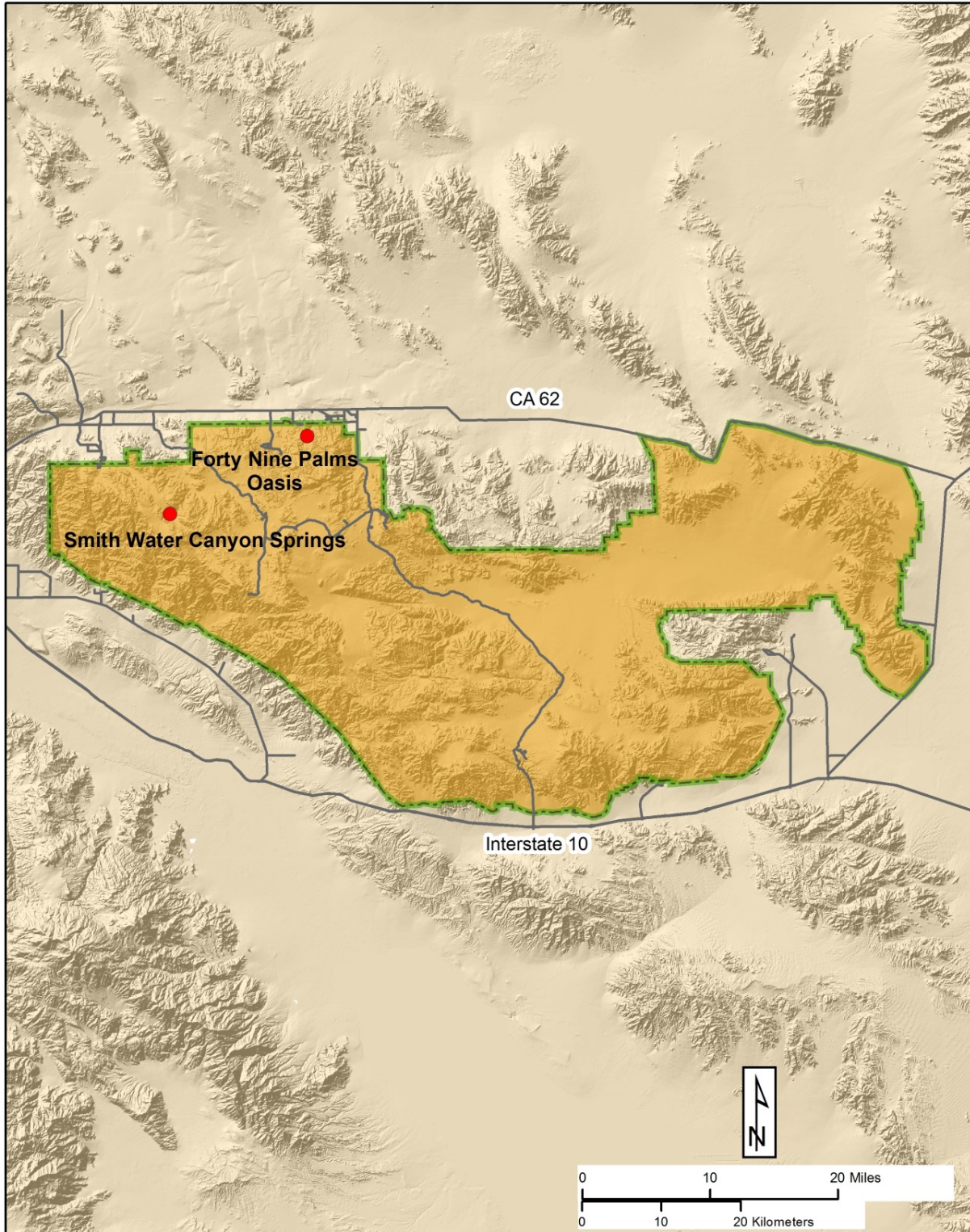
At JOTR, two springs have been selected for monitoring- Fortynine Palms Oasis and Smithwater Canyon Springs (Figure 1). MOJN I&M crews visit these springs each quarter, and monitor both the extent of surface water present and water quality. Every two years, MOJN I&M collects water samples for chemical analysis and samples of benthic macroinvertebrates (BMI). The purpose of this monitoring is to provide data regarding the overall health of the aquatic ecosystems in the monitored springs, and to provide baseline information that can be used to evaluate management actions or visitor impacts.

MOJN I&M visited Fortynine Palms Oasis and Smith Water Canyon Springs in JOTR in March, June, September, and December of 2014. Water quality and spatial extent data were collected on each of these visits, and BMI samples were collected on the March 2014 visit. This report presents data from these visits.

### Fortynine Palms Oasis

Fortynine Palms Oasis is a fan-palm oasis located at the confluence of two washes near the park's northern boundary. The oasis consists of approximately 1 ha of dense riparian vegetation, principally fan palms (*Washingtonia filifera*) and cattails (*Typha sp.*) (Figure 2). The oasis is a major water source for bighorn sheep (*Ovis canadensis nelsoni*) in the park (e.g., Douglas 1976, Longshore et al. 2009), and is the destination for a popular day hike. Red-spotted toads (*Bufo punctatus*) and California treefrogs (*Pseudacris cadaverina*) have been observed in the oasis (Gallegos et al. in prep.).

Surface water is present year round in pools below the palms. There is generally no flow between or from the pools, suggesting that the discharge of the spring is consumed by evapotranspiration. However, the wash is scoured by major storms every few years. The USGS monitored discharge in the wash below the oasis from 1963 to 1971, and found that, while wash was dry for all but a few days of the year, more than 100 acre-feet of water could pass through it in a single storm event (Nishikawa et al. 2004). The USGS attempted to monitor water levels in the oasis pools in 2005 and 2006, and had their equipment destroyed by a storm (Gallegos et al. in prep.). Each time the oasis is scoured, the number of pools changes, along with their positions and depths. The frequent changes in the pools present a challenge for long-term monitoring.



**Figure 1.** Map of springs selected for monitoring in JOTR.



**Figure 2.** Fortynine Palms Oasis in June 2014.

### **Smith Water Canyon Springs**

Smith Water Canyon Springs (Figure 3) is located in Smith Water Canyon, a steep, narrow canyon that descends approximately 1500 feet in elevation from Covington Wash to Quail Wash. Five ephemeral spring outlets are monitored: Outlet 1 through Outlet 5 (Table 1). During the winter months, the flow from these outlets creates five springbrooks. At the highest flows, each springbrook can reach the next spring outlet, creating a continuous stream from Outlet 1 to the water fall below Outlet 5. During the summer months, all five outlets can be dry. Smith Water Canyon is an important water source for desert bighorn sheep (*Ovis canadensis nelsoni*). Mountain lions (*Puma concolor*) have also been observed in the canyon.



**Figure 3.** Smithwater Canyon Springs in December 2013.

**Table 1.** Locations of monitored spring outlets in Smithwater Canyon. Coordinates are for UTM zone 11, NAD83.

<b>Outlet</b>	<b>Northing (m)</b>	<b>Easting (m)</b>
Outlet 1	3765682	566553
Outlet 2	3765693	566619
Outlet 3	3765676	566637
Outlet 4	3765675	566674
Outlet 5	3765638	566711

## **Methods**

The MOJN I&M SLS protocol monitors two springs in JOTR: Fortynine Palms Oasis and Smith Water Canyon Springs. These springs were selected in consultation with park managers. Each spring is visited quarterly to measure water quality and spring discharge. Every two years, water and BMI samples are collected from the springs. There are no extant populations of springsnails to monitor in either of these springs. Monitoring methods are fully described in the MOJN I&M SLS protocol (Moret et al. in prep.).

### **Open Water Area**

The availability of surface water at Fortynine Palms Oasis is monitored by measuring the total open water area of the spring pools. Each pool is measured and sketched to scale on graph paper, allowing the area to be calculated. The number of pools and furthest downstream extent of water are also recorded.

### **Springbrook Length**

The availability of surface water at Smith Water Canyon Springs is monitored by recording the presence or absence of water at each of five spring outlets, and then measuring the length of each springbrook.

### **Water Quality**

MOJN I&M uses a YSI 556 MPS to record temperature, pH, specific conductance (SpCond), and dissolved oxygen (DO). Water quality is measured in the furthest upstream pool or source.

### **BMI Sampling**

A multi-pool grab BMI sample is collected from each spring. The sampling method is not intended to produce quantitative data, but rather a snapshot of the taxa present in the spring. BMI are collected from two 10 cm x 10 cm quadrats in each pool or springbrook, and composited into a single spring-wide sample. The BMI samples are analyzed by the Utah State University National Aquatic Monitoring Center (the BugLab).

## Spatial Extent of Surface Water

### Open Water Area at Fortynine Palms Oasis

Table 2 shows the total number of pools and total open water area observed during quarterly visits in 2014 and during the initial test of the method in May 2013. The open water area observed during the dry season visits (June 2014 and September 2014) was approximately half the open water area observed during the wet season visits (May 2013, March 2014, and December 2014). At the time of the September 2014 visit, the crew observed that the oasis appeared to have been disturbed by flooding due to monsoonal storms. This disturbance may have increased the number of observed pools in September and December without affecting the open-water area.

**Table 2.** Quarterly pool and water abundance data for Fortynine Palms Oasis.

Date	Number of Pools	Total Open Water Area (m <sup>2</sup> )
5/14/2013	12	115.5
3/27/2014	14	129.0
6/27/2014	10	60.5
9/26/2014	17	63.0
12/22/2014	39	121.8

### Springbrook Length at Smithwater Canyon Springs

Table 3 shows the results of springbrook length monitoring during quarterly visits in 2014. In March 2014, all of the outlets were flowing. In June 2014, all of the outlets were dry. In September 2014, some water was observed at Outlet 1, and all of the other outlets were dry. In December 2014, water was observed at the three most upstream outlets, and the two most downstream outlets were dry. The springbrook emerging from Outlet 5 flows over a steep waterfall and makes measurement of length unpractical for safety reasons.

**Table 3.** Quarterly springbrook length data for Smith Water Canyon Springs.

Date	Outlet 1 Springbrook Length (m)	Outlet 2 Springbrook Length (m)	Outlet 3 Springbrook Length (m)	Outlet 4 Springbrook Length (m)	Outlet 5 Springbrook Length (m)
3/28/2014	3.6	36.5	21	19	water present*
6/26/2014	dry	dry	dry	dry	dry
9/25/2014	2	dry	dry	dry	dry
12/23/2014	5.3	8.9	6.6	dry	dry

\* Outlet 5 springbrook flows over waterfall, so length cannot be safely measured.

## Water Quality

The focus of the 2014 pilot study was the development of methods for water quantity and BMI monitoring, so water quality data were not collected consistently. The data that were collected are given in Table 4.

**Table 4.** Quarterly water quality data for Fortynine Palms Oasis and Smith Water Canyon Springs.

Spring	Date	Location	Depth (m)	Temp (°C)	pH	SpCond (µS/cm)	DO (%)
Fortynine Palms	9/26/2014	Farthest Upstream Pool	Surface	22.60	7.40	-	103
			Middle	21.79	7.22	566	145
			Bottom	21.64	7.21	569	4
Fortynine Palms	12/22/2014	Farthest Upstream Pool	0.00	11.11	7.11	671	32
			0.20	11.12	7.11	672	30
			0.41	11.12	7.12	673	31
			0.61	11.12	7.13	675	27
Smith Water	3/28/2014	Outlet 1	-	15.9	-	-	-
		Outlet 2	-	-	-	-	-
		Outlet 3	-	16.7	-	1058	-
		Outlet 4	-	12.4	-	987	-
		Outlet 5	-	-	-	-	-
Smith Water	12/23/2014	Outlet 1	-	11.54	6.86	1179	44

### Fortynine Palms Oasis

Two water quality depth profiles were collected in the farthest upstream pool at Fortynine Palms Oasis: one in September 2014 and one in December 2014.

The recorded temperatures were much higher in September (21.64°C to 22.60°C) than December (11.11°C to 11.12°C), suggesting a strong seasonal variation.

The recorded pH values were circumneutral (7.11 to 7.40) on both visits.

Specific conductivity was greater in December than in September. Further measurements are needed to determine if this difference is due to a consistent seasonal variation or to another factor (e.g., recent rainfall).

The dissolved oxygen percent saturations recorded in September 2014 varied strongly with depth, ranging from 103% at the surface to 4% at the pool bottom. In contrast, the dissolved oxygen saturations recorded in December 2014 ranged only from 27% at the surface to 32% at the pool bottom. As discussed in the previous paragraph, the surface measurement in September 2014 may have been made with the probe only partly submerged. Further data collection will allow us to better understand seasonal variations in dissolved oxygen saturation.

### Smithwater Canyon Springs

In March 2014, temperature and specific conductivity measurements were collected in Smithwater Canyon Springs outlets 1, 3, and 4. In December 2014, temperature, pH, specific conductivity, and dissolved oxygen saturation were measured in Smithwater Canyon Springs outlet 1.

Temperatures in March ranged from 12.4 °C to 16.7 °C. It is possible that the range may be due to increased temperatures at the unshaded outlets or to differences in flow rates (lower flow rates result in greater equilibration with atmospheric temperatures at the outlet). The temperature of outlet 1 in December was 11.54°C.

The only measured pH (6.86 in outlet 1 in December) was circumneutral.

Specific conductivity ranged from 987 µS/cm to 1179 µS/cm.

The dissolved oxygen saturation recorded in outlet 1 in December was 44%.

## Benthic Macroinvertebrates

BMI samples were collected from Fortynine Palms Oasis on March 27, 2014 and from Smithwater Canyon Springs on March 28, 2014 and submitted to the Buglab for taxonomic identification and enumeration. Selected population metrics for the samples are given in Table 5. The number of each taxon present in each sample is given in Table 6.

**Table 5.** Selected population metrics for March 2014 BMI samples.

Population Metric	Fortynine Palms Oasis	Smith Water Canyon Springs
# of Taxa*	16	7
Abundance	586	540
% Abundance of Dominant Taxon	30% (Tanypodinae)	60% (Chironominae)
# of EPT** Taxa*	2	1
EPT Abundance	172	2
# of Shredder Taxa*	0	0
Shredder Abundance	0	0
# of Scraper Taxa*	2	1
Scraper Abundance	1	2
# of Collector-Filterer Taxa*	1	1
Collector-Filterer Abundance	14	0
# of Collector-Gatherer Taxa*	4	3
Collector-Gatherer Abundance	328	533
# of Predator Taxa*	8	1
Predator Abundance	222	5
# of Long-Lived Taxa*	6	0

\* Standardized to operational taxonomic units (OTUs) and a fixed count of 300 as discussed in Cuffney et al. (2007). Standardized taxa counts may not be consistent with abundances due to changes in feeding group as species are grouped in to genera.

\*\* EPT stands for Ephemeroptera, Plecoptera and Trichoptera, three orders of insect associated with high water quality in streams.

Table 5 shows that Fortynine Palms Oasis contains a greater diversity of BMI taxa than Smith Water Canyon Springs. At Fortynine Palms Oasis, the dominant taxon accounts for 30% of BMI abundance while at Smith Water Canyon Springs, the dominant taxon accounts for 60% of BMI abundance. Both dominant taxa are subfamilies within the non-biting midge (Chironomidae) family.

The two locations contain a relatively high diversity and abundance of collector-gatherer taxa, nearly all of which are non-biting midges. Collector-gatherers burrow into sediment and feed on fine particulate organic matter (FPOM). It is possible that these BMI are better able to withstand monsoonal floods than BMI from other functional feeding groups.

Fortynine Palms Oasis contains a greater diversity and abundance of predator and long-lived taxa than Smith Water Canyon Springs. The continuous presence of water, relatively consistent discharge,

and variety of prey at the oasis likely permit the development of more complex trophic interactions and provide suitable habitat for taxa with multiyear life cycles.

Fortynine Palms Oasis also contains a larger abundance of EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa, particularly mayflies (*Callibaetis sp.*) and caddisflies (*Hydroptila sp.*). EPT taxa are particularly sensitive to water quality and pollution in streams, so their presence may be an indication of high water quality in the oasis. Smith Water Canyon Springs can become entirely dry during the summer and may tend to support hardier taxa that can withstand greater fluctuations in water quality and availability.

**Table 6.** BMI in March 2014 samples listed by taxa.

Phylum	Class	Order	Family	SubFamily	Genus	Fortynine Palms	Smith Water
Annelida	Clitellata					2	0
Arthropoda	Arachnida	Trombidiformes				4	0
Arthropoda	Insecta	Coleoptera	Dytiscidae			1	0
Arthropoda	Insecta	Coleoptera	Dytiscidae	Agabinae	Agabus	0	1
Arthropoda	Insecta	Coleoptera	Scirtidae			1	0
Arthropoda	Insecta	Diptera	Ceratopogonidae			12	0
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	Ceratopogon	0	1
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	Probezzia	1	0
Arthropoda	Insecta	Diptera	Chironomidae			0	5
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		126	325
Arthropoda	Insecta	Diptera	Chironomidae	Orthoclaadiinae		45	198
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae		174	0
Arthropoda	Insecta	Diptera	Culicidae			14	0
Arthropoda	Insecta	Diptera	Culicidae		Culiseta	0	2
Arthropoda	Insecta	Diptera	Dixidae		Dixella	4	0
Arthropoda	Insecta	Diptera	Dolichopodidae			0	1
Arthropoda	Insecta	Diptera	Muscidae			0	2
Arthropoda	Insecta	Diptera	Stratiomyidae		Caloparyphus	0	2
Arthropoda	Insecta	Ephemeroptera	Baetidae		Callibaetis	150	1
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae			1	0
Arthropoda	Insecta	Odonata	Aeshnidae		Aeshna	1	0
Arthropoda	Insecta	Odonata	Aeshnidae		Anax	1	0
Arthropoda	Insecta	Odonata	Coenagrionidae			18	0
Arthropoda	Insecta	Odonata	Coenagrionidae		Argia	2	0
Arthropoda	Insecta	Odonata	Coenagrionidae		Enallagma	1	0
Arthropoda	Insecta	Odonata	Libellulidae			6	0
Arthropoda	Insecta	Trichoptera	Helicopsychidae		Helicopsyche	0	1
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilinae	Hydroptila	21	0
Chordata	Amphibia	Anura				1	0

## Discussion

The open water area at Fortynine Palms Oasis was approximately twice as large during the wet season as during the dry season in 2014. The total open water area measurements in June 2014 and September 2014 were very similar despite a changed number of pools, suggesting the method can produce consistent data despite geomorphic changes.

The number of flowing spring outlets observed in Smithwater Canyon ranged from 0 to 5, suggesting the method can be used to track seasonal changes in spring discharge.

Water quality was not the focus of the pilot study, and relatively few measurements were made. In the future, a depth profile of water quality measurements will be collected at the furthest upstream pool in Fortynine Palms Oasis (similar to the measurements made in December 2014). Water quality measurements will be made at all flowing outlets in Smithwater Canyon.

The BMI data suggest that Fortynine Palms Oasis supports a much more diverse invertebrate population than Smithwater Canyon, with more taxa in more functional groups. The comparison of data from the two springs suggests that possible metrics for monitoring the health of Fortynine Palms Oasis might include number of taxa, the number of EPT taxa, percent dominant taxon, number of predator taxa, and number of long-lived taxa.

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