Sonoran Desert Network
Monitoring Brief

National Park Service
U.S. Department of the Interior

Intermountain Region
Inventory & Monitoring Program

2014

Streams Monitoring at Gila Cliff Dwellings National Monument

Importance

Riparian habitats constitute less than 2% of the land area in the American Southwest, but support the highest density and abundance of plants and animals of any habitat type, making streams and associated riparian areas critical to the ecological integrity of the region. Riparian areas supply food, cover, and water, and serve as migration routes and habitat connectors, for a variety of wildlife. They also help control water pollution, reduce erosion, mitigate floods, and increase groundwater recharge. Riparian systems perform numerous ecosystem functions important to human populations, yet are one of the most endangered forest types in the United States.

Monitoring Objectives

The overall goal of the Sonoran Desert Network (SODN) streams monitoring program is to detect broad-scale changes in aquatic and riparian ecological condition by observing selected ecological drivers, stressors, and processes. Specific, measurable objectives for streams monitoring at Gila Cliff Dwellings National Monument (NM) are to determine the status of and detect long-term trends in:

- **Water quality** for daily, seasonal, and annual core water quality parameters (temperature, pH, dissolved oxygen, specific conductivity, turbidity), and seasonal nutrients, metals, inorganics, and bacteria.
- **Aquatic macroinvertebrates** for relative abundance of selected taxa and community structure and selected multimetric indicators of biotic integrity.
- **Surface water quantity** for seasonal and annual base flow conditions; frequency, magnitude, and duration of low flow and-flood events; and extent of wet and dry areas.
- **Channel morphology** for cross-sectional area, sinuosity, channel slope, and sediment size distribution.
- **Riparian vegetation cover** for dominant and common (>10%) perennial species.
- **Fish** for communities on local and regional scales.

Status of the Effort

During 2013, SODN completed routine water quality monitoring during quarterly site visits, including water quality sampling and water quantity measurements. These efforts were aided by use of a logging multiparameter water quality probe, which was deployed for two weeks during each quarter (except winter, due to temperature limitations of the equipment). Aquatic macroinvertebrates were sampled in October 2012 and sent to the National Aquatic Monitoring Center (Bug-Lab) at Utah State University for taxonomic identification and analysis. SODN continued its collaboration with the U.S. Environmental Protection Agency (EPA) by sending water samples from fall, spring, and summer sampling to the U.S. EPA Region 8 Laboratory for analysis of emerging contaminants.

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West Fork of the Gila River.

SODN produced four field summary reports presenting provisional data collected during quarterly sampling periods. All measured water quality parameters in fall, spring, and summer met state water quality standards. The only water quality exceedances (for aluminum and turbidity) were observed in winter, likely due to snowmelt.

Management Concerns

Runoff water quality

Under baseflow conditions, the West Fork of the Gila River is a pristine, natural stream. However, like any stream during flow events, the river's water quality conditions temporarily degrade as metals and nutrients are carried into the stream by precipitation runoff and increased water levels. In the West Fork, however, this process is likely exacerbated by the effects of the Miller Fire (2011) and the Whitewater-Baldy Complex Fire (2012).

During the winter, turbidity and total aluminum exceeded state water quality criteria, and nitrate was detected. Turbidity is likely to increase in fire-affected areas as runoff carries ash and sediment from unstable landscapes. High turbidity was also observed in 2011, and throughout the spring and summer of 2012. Higher turbidity for longer time periods can have negative effects on stream ecosystems by reducing light penetration into the water column, photosynthesis, and dissolved oxygen concentrations. The suspended particles can

Riparian vegetation is holding its own against potential invaders after the recent fires.

bury fish eggs, decrease the interstitial volume of macroinvertebrate habitat (i.e., the space between the rocks where creatures live), clog fish gills, and generally decrease feeding success.

Aluminum occurs naturally in surface waters and soils from weathering of rocks and minerals. Following fires, the concentration of aluminum in streams can increase as substrate materials are more exposed and there is typically a larger volume of surface runoff following rain events. In the winter, total aluminum was 50% higher than the state-established acute criteria for aquatic life. Acute toxicity is defined as a stimulus severe enough to induce a response in 96 hours or less. The total aluminum result from summer 2012 was nearly nine times the acute standards. Before the fires of 2011 and 2012, aluminum exceeded the state criteria just once in five years of sampling, during a flow event. The rocks and sediment of the West Fork watershed may contain large amounts of aluminum that was exposed by the fires, then eroded and washed into the stream during precipitation events.

Nitrate, which leaches from soils, is a key nutrient used by bacteria and plants for growth, but toxic to aquatic organisms at higher concentrations. It is uncommon for nitrate to be detected at Gila Cliff Dwellings NM. Its concentration in surface waters typically increases following precipitation (especially when the landscape is less stable), so the detections in 2012 and 2013 were likely associated with the recent fires.

Habitat degradation

The watershed of the West Fork of the Gila River remains unstable following the two fires. Recently, the amount of runoff, and the concentration of particles it carries following a rain event, have been higher than before 2011. The speed at which the aquatic community rebounds will depend on high-flow events, especially winter/spring flooding events that scour the fine sediment and move it downstream.

Invasive exotic plants

Preventing the spread and dominance of exotic species is an important goal at the park. Preliminary results indicate that there has been only a small increase in non-native riparian vegetation taxa per plot since the fires. This is good news, likely due to the remote location of the monument and restriction of public access to much of the riparian area.

Flooding and channel change

Since the fires, the West Fork of the Gila River have experienced a few bankfull flows, including one in mid- September. These flows were below flood levels and are considered channel-maintenance events that transport sediment downstream, remove constricting islands, and scour in-channel vegetation, but do not drastically change channel morphology. However, the flood that occurred on the Middle Fork of the Gila River in mid-September provided an example of the damage that a monsoon storm could create. The landscape throughout the watershed will remain altered and less stable for years to come.

Conclusions

The West Fork of the Gila River within Gila Cliff Dwellings NM is a high-quality, mountainous stream. Prior to the fires, the West Fork was within the historic range of natural variability and relatively free of anthropogenic stressors. The fires have resulted in a currently degraded aquatic habitat and an increased threat of flooding, erosion, and sedimentation—a situation that will be present for several years. The recent fires provide a rare opportunity to monitor the effect of fire on the stream ecosystem and the response of the riparian area.

Contact

Evan Gwilliam, evan_gwilliam@nps.gov

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Middle Fork of the Gila River after flooding, September 24, 2013.