

Stream Monitoring in the Sonoran Desert Network

Introduction and Background

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 in the region, making streams and associated riparian areas critical to the ecological integrity of the greater Sonoran Desert. Riparian areas supply food, cover, and water for a large diversity of animals and serve as migration routes and habitat connectors for a variety of wildlife. They are also important in controlling water pollution, reducing erosion, mitigating floods, and increasing groundwater recharge. Riparian systems also perform numerous ecosystem functions important to human populations, yet are one of the most endangered forest types in the United States.

Because of their importance, streams were chosen as a focus for monitoring in the National Park Service (NPS) Sonoran Desert Network (SODN). Portions of three major river systems (or their tributaries) are found within four SODN park units: Gila Cliff Dwellings, Montezuma Castle, and Tuzigoot national monuments, and Tumacácori National Historical Park. Vital signs monitoring of streams by SODN supports a comprehensive understanding of aquatic and riparian ecosystems and integrates 7 vital signs: surface water quantity, core water quality parameters, nutrient dynamics, microorganisms, pollutant metals, benthic macroinvertebrates, stream channel morphology, vegetation community dynamics (riparian), exotic plant species – status and trend (riparian), and exotic plant species – early detection (riparian). In addition, fish and crayfish will be monitored as funding is available.

Monitoring Objectives

The goal of the SODN stream monitoring program is to detect broad-scale changes in aquatic and riparian ecological condition by observing selected ecological drivers, stressors, and processes. The monitoring objectives for the vital signs are:

- Determine the status and long-term trends in total cross-sectional area, sinuosity, channel slope, and sediment composition;
- Determine the status and long-term trends in vegetative cover of all lifeforms and dominant and common (>25% vegetative cover) perennial riparian species;

PROJECT SUMMARY



NPS hydrologist Colleen Filippone beside the West Fork of the Gila River at Gila Cliff Dwellings National Monument.

- Determine the occurrence and long-term trends in the frequency of select non-native invasive perennial and annual species;
- Determine long-term trends in stream flow in perennial stream reaches in SODN parks;
- Detect seasonal and long-term trends in water temperature, specific conductance and derived total dissolved solids, turbidity, pH, dissolved oxygen, and discharge;
- Determine long-term trends in total nitrogen, total phosphorus, metals and E. coli concentrations;
- Determine long-term trends in trophic community composition of benthic macroinvertebrates;
- Determine seasonal and long-term trends in multi-metric indicators of biological integrity (IBI) based on benthic macroinvertebrate assemblages;
- Contextualize fish community in the region.

Sampling Design

The sampling design for stream monitoring in Sonoran Desert Network parks employs permanent sampling locations (reaches). The sampling reaches span the entire length of a perennial stream within a park. All parameters of the vital signs are monitored within each reach (i.e., their monitoring is co-located), but the specific sampling locations vary among parameters. Each reach is divided into 10 equal-length segments, resulting in 11 equally spaced sampling locations at which most parameters are sampled. Sampling frequency varies by vital sign (Table 1).

Table 1. Sampling frequency of vital signs.

Frequency	Vital sign
Quarterly	Surface water quantity
	Core water quality parameters
	Biological condition
	Primary nutrients
	Alkalinity
Annually	Aquatic macroinvertebrates
	Pollutant metals
	Fish and Crayfish
Every five years	Stream channel morphology
	Riparian vegetation

Field Methods

Stream Channel Morphology

To date, SODN monitors stream channel morphology by surveying eleven channel cross-sections and a longitudinal profile with a transit total station. SODN is currently investigating the potential use of LIDAR (Light Detection and Ranging), a remote sensing system used to collect topographic data, instead of total station surveying. LIDAR has the advantage of generating a topographic surface rather than discrete cross-sections produced by a total station survey. Riparian vegetation may also be monitored using LIDAR. A modified Wolman pebble count quantitatively describes the substrate composition of the channel bed.

Riparian Vegetation

Vegetation sampling is done along 20-m transects that are all located along the eleven sampling locations. Vegetation is recorded within three height categories along transect using the line-point intercept method, with points spaced every 0.5-m. Soil cover is recorded to substrate class (e.g., cobble, gravel, litter). In the space 1-m on either side of the transect, the occurrence of any species/lifeform not measured on the adjacent line-point transect will be recorded to determine frequency.

Surface Water Quality

Core water quality parameter measurements are taken using a multiprobe sonde. Discharge is determined using a pygmy meter or a sonic Doppler sensor. All other water quality measurements (primary nutrients, alkalinity, biological condition, and pollutant metals) are taken from bottle samples collected concurrently with core parameter measurements.

Surface Water Quantity

SODN will utilize data collected by the U. S. Geological Survey and the NPS at stream gauges near SODN parks.

Aquatic Macroinvertebrates

Macroinvertebrates are sampled at all 11 sampling locations within the reach using a timed kick-net sample. Samples are combined into a single composite sample for the reach.

Fish & Crayfish

SODN will utilize fish survey data collected in the fall by Arizona Department of Game and Fish, Friends of the Santa Cruz River, and other agencies or organizations.

Protocol Development Status

Initially, six aquatic and riparian monitoring protocols were being written for the SODN. By 2008, all of the stream-related protocols (channel morphology, water quality, water quantity, benthic macroinvertebrates, fish, and riparian vegetation) were consolidated into one integrated “Streams” protocol. Following the 2008 SODN program review, several changes were made to the Streams protocol. The SODN Streams protocol is approximately 85% complete, with much of the remaining work needed on later chapters (such as staffing, schedule, and cost) and the unresolved issues of riparian vegetation and fish. Fifty-six standard operating procedures have been completed, but need to be updated to reflect new equipment. A draft database and on-line project tracking system has been built by Sonoran Institute cooperators. Output functions for populating NPStoret (a servicewide mandate) are in development by Sonoran Institute cooperators..

In 2005, the SODN and the Sonoran Institute initiated a pilot study at Gila Cliff Dwellings NM to evaluate channel morphology field methods. In the following year, the pilot study expanded to include Tumacácori NHP and Montezuma Castle NM and all vital signs except fish. Tuzigoot NM was added to the pilot study in 2007. Sampling of all parameters except riparian vegetation and fish became routine by 2008, revealing excess values for *E. coli* and some pollutant metals at a number of units. Another pilot study addressed riparian vegetation along geomorphic gradients (using line intercept techniques) at all 5 units with perennial streams. A new field-portable coliform bacteria/*E. coli* incubator system was purchased and tested in late 2008. Fish remains on the backburner due to cost and sampling impact issues.

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