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Water Quality Monitoring Flows On

Results of the 2011 Water Quality Monitoring Season for Saugus Iron Works NHS

Background

The Northeast Temperate Network (NETN) monitors a variety of natural resource indicators, which it calls “vital signs”, for 12 parks in the northeast and the Appalachian National Scenic Trail. The vital signs for freshwater bodies are water chemistry, nutrient enrichment, water quantity, and the detection of invasive plant species. These were chosen to address the NPS Inventory and Monitoring Program objective to detect change in the status of physical, chemical, or biological attributes of the ecosystem.

Methods

Detailed descriptions of all monitoring methods can be found in NETN’s Freshwater Monitoring protocol available for download from the network’s website. Two stream sites are sampled in May and August by a cooperator from the University of Vermont or a NETN hydrologic technician. Physical and water chemistry parameters are measured and water samples are collected for analysis at the University of Maine. All monitoring data are incorporated into a series of comprehensive databases that feed into an EPA data system.

The Saugus River site is at the U.S. Geological Survey continuous-record streamflow-gage site just upstream of the park boundary which has been in operation since 1994. Although the station is upstream of the park, this station adequately represents water quality where the river enters the park. The Saugus River is classified as a warm water fishery, capable of supporting bass, pickerel, sunfish, and similar species.

The second sample site is located at the Turning Basin. The Turning Basin is a modified tidal basin, first used by the original iron works from 1650-1679 as a location for boats to turn around at the head of the estuary. Brackish water intrudes into the basin during high spring-time tides and affects the water quality. The river channel within and below the Turning Basin, including the benthic zone, intertidal surface, and floodplain was the subject of a major restoration project between the 2007 and 2008 sampling years.

Sampling parameters included water quality measurements (pH, specific conductance, temperature, and dissolved oxygen), weather. Stream flow and stage are not collected during sampling events because a USGS gage provides continuous stream flow data. Water samples obtained in

May and August were analyzed for acid neutralizing capacity (ANC), color, and nutrients. Nutrient chemistry parameters were analyzed from a grab sample.

Results and Findings

Complete details of 2011 monitoring season findings can be found in the full report which is available for downloading from the website. Brief synopses of some findings are available below.

Specific conductance measures the ability of water to carry an electrical current. If it increases it can be an indicator of pollutants in the water. Specific conductance values for 2011 were within the appropriate range for all park waters.

The **pH** of a water body reflects how acidic or basic the water is, measured on a scale of 1 to 14, with 7 being neutral. Acid waters are below 7, and alkaline waters are above 7. A one unit change in pH represents a 10-fold change in acidity or alkalinity. Massachusetts standards, similar to those of most northeast states, indicate that a pH between 6.5 and 8.3 is within the acceptable range. pH values from the 2011 monitoring season were slightly basic, and were between the upper and lower Massachusetts water quality standards.

Temperature can affect water chemistry and biology. For example, the amount of oxygen that water can hold is



The Turning Basin at Saugus Iron Works NHS. Eric Davis photo.

directly related to the temperature of the water: the higher the temperature, the less oxygen it can hold. Temperature can also determine the kinds of plants and animals found in the lake or pond. Certain species of fish, insects, and algae will predominate during the cooler temperatures of the spring and fall, yet be less apparent during the warmer temperatures of summer. Surface water temperatures appeared to be within the normal range of variability in 2011.

Dissolved oxygen (DO) is a critical indicator of water quality because aquatic life generally needs certain concentrations to thrive. Low oxygen can directly kill or stress organisms such that they will not be able to successfully reproduce or grow. Both park DO measurements in 2011 were well above the stringent state stream DO standard.

Color in pond and stream water is caused by natural metallic ions, humus and peat materials, plankton, weeds, and industrial wastes. **Apparent color** is determined using water samples that have not had suspended particles filtered out. Color can be a rough indicator for organic acidity. Color values from both sites were high in all 2011 samples. Saugus River historic measurements were more variable. This could be the effect of runoff and sediment input to the river, rather than dissolved constituents, since the samples were not filtered before analysis. Field turbidity measurements, which began during the current monitoring season, may provide additional information on the impacts to park streams from episodic runoff events.

Acid neutralizing capacity (ANC) is also known as alkalinity, or buffering capacity. It is due primarily to the presence of naturally available bicarbonate, carbonate, and hydroxide ions, with bicarbonate being the major form. Acid neutralizing capacity measured in the 2011 samples illustrates that the park waters were well-buffered, likely due to the underlying geology. The May ANC measurements follow the typical seasonal pattern of being lower than the August values. This is likely due to the contribution of episodic acidification from spring snowmelt and runoff (and also illustrates the ability of the robust ANC to counteract the acidification pulses).

Nutrient enrichment and the acceleration of eutrophication (when waters become rich in mineral and organic nutrients that promote a proliferation of plant life - especially algae) have been identified in most NETN parks as one of the stressors of greatest concern. Several forms of total and dissolved phosphorus and nitrogen are measured to give managers information regarding the status and productivity of freshwater systems. Phosphorus concentrations were in the moderate to high range, indicating that some nutrient enrichment is occurring in park waters. Test results for several forms of nitrogen were moderate-to-low.

Stream discharge measurements can be used to calculate loading of nutrient chemical constituents (flow X concentration), and also provide a record of variations in stream flow. Streamflow in 2011 followed the expected seasonal sequence of high discharge in the spring to minimal flow in July and August, with recovery in September and October. NETN staff are currently reviewing discharge and stage measurement methodology and quality assurance/quality control procedures in order to enhance the quality and utility of the water quantity data. It is recommended that stage (water level) measurements should be taken in the Turning Basin to document changes over time and to develop a relationship between Turning Basin stage and the discharge measurements from the USGS gage.

Summary

Study organizers recommended that in-place water quality measurements be taken with specialized equipment at both park sites in future monitoring. Two extremely high specific conductance data points from the Turning Basin (August 2009 and 2010) that had no corresponding high values in the USGS conductance data from the Saugus River suggest that there are unique water quality influences and characteristics at each site, despite their close physical proximity. Tidal influence is clear from observations of park staff, and is borne out in the Turning Basin monitoring report.

Monitoring under the NETN protocol builds on the historic water quality monitoring by park staff and other agencies to provide critical baseline information on the chemical and physical status of the water resources Saugus Iron Works National Historic Site. Several changes will be implemented in the 2012 monitoring season, including taking monthly stream turbidity measurements, and the addition of sulfate, chloride, and dissolved organic carbon (DOC) analyses to the May and August water chemistry testing. These changes will expand the scope and usefulness of the monitoring data. As more data are collected, the ability to detect changes outside this natural range of variability will increase, which in turn will more clearly indicate the status of the vital signs of water quality, nutrient enrichment, water quantity, and the detection of invasive plant species.

More Information

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Full Report online at:
<http://science.nature.nps.gov/im/units/NETN/index.cfm>



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