



Water Quality Monitoring

Importance

Most Northern Colorado Plateau Network (NCPN) parks are located in semi-arid to arid environments where water is a major factor in determining the distribution of flora, fauna, and historic human habitation. Additionally, the abundance and quality of water resources reflect human activities and land use in and near parks, and are a primary factor influencing park visitation and recreational activities. Water bodies in national parks are protected by the Clean Water Act and other policies that prevent unacceptable levels of pollution and establish acceptable values for other water-quality measures. Park managers need information on status and trends in surface-water quality and quantity to comply with the Clean Water Act and to mitigate historic and future impacts to park water resources that may have ecological and social significance.

Long-term Monitoring

Water quality monitoring sites are selected based on historic impacts, perceived threat, current monitoring by others, or to determine baseline status as a starting point for long-term trend detection. As many as 30 water-quality parameters are measured at each site visit. At every site, the core parameters (specific conductivity, flow, temperature, pH, and dissolved oxygen) are measured as basic indicators of water quality using portable water-quality sensors. Measurements are then compared to standards to determine whether water-quality goals are being met and if, over time, conditions are changing beyond acceptable normal ranges. NCPN water quality monitoring is a coordinated effort between the network, 11 park units, the U.S. Geological Survey, and the State of Utah.

Status and Trends

Data collected since July 2007 indicate that water quality in the NCPN is good overall. Bacteria concentrations at Bryce Canyon NP have decreased since managers have repaired boundary fences, but most water quality problems identified in previous years are still extant (see <http://science.nature.nps.gov/im/units/ncpn/WQBrief.cfm> for previous briefs and reports). Newly identified issues include some evidence for introduction of quagga mussels to reservoir systems in Curecanti NRA, and seasonally elevated *E. coli* observed in six tributary streams there since 2006. Recent monitoring indicates that aluminum and phosphorus concentrations at Natural Bridges and Hovenweep NMs have exceeded criteria for aquatic life, and that sites in those parks with very low flows occasionally had low dissolved oxygen. Nutrient and metal exceedances like these have been observed in other springs and streams on the Colo-



NPSO, THOMAS

Gunnison River, Curecanti NRA.

rado Plateau, and are often caused by natural conditions. The first year of monitoring cave pools at Timpanogos Cave NM indicated good water quality.

Management Implications

In February 2009, 165.5 miles of the Virgin River and its tributaries, mostly in Zion NP, were designated as Wild and Scenic Rivers—the first such designation in Utah’s history. The National Wild and Scenic Rivers System was created by Congress in 1968, to preserve rivers with outstanding natural, cultural, and recreational values in free-flowing condition for the enjoyment of present and future generations. The Utah Division of Water Quality is still considering a National Park Service petition to upgrade classification of North Fork Virgin River (also in Zion) from secondary-contact to primary-contact recreation. Though park management efforts have resulted in positive effects on water quality, the introduction of new threats, such as the possibility of quagga mussels in Curecanti NRA reservoirs, speaks to the need for continued vigilance and collaboration in water quality monitoring and management into the foreseeable future. The next biannual report for NCPN water quality monitoring will be available in 2010.

Network park units where the NCPN monitors water quality

Arches NP	Dinosaur NM
Black Canyon of the Gunnison NP	Hovenweep NM
Bryce Canyon NP	Natural Bridges NM
Canyonlands NP	Timpanogos Cave NM
Capitol Reef NP	Zion NP
Curecanti NRA	

NP = National Park; NM = National Monument; NRA = National Recreation Area

Diving Deeper into Water Quality

Most NCPN water quality sampling is conducted monthly, with the goal of quantifying status and trends over time and evaluating results against Clean Water Act standards. However, annual, seasonal, and even diurnal (daily) variations in water chemistry can confound the interpretation of these data. Understanding how core parameters vary diurnally will help us to determine the time of day when water quality violations are most likely to occur, and to target our sampling during those times. After noting unusually high summertime pH and temperatures in North Creek (Zion NP) in 2006 and 2007, we began a pilot study of diurnal cycles. On four different days in 2008 and 2009, the NCPN used continuous water quality monitoring sensors to monitor parameters in North Creek at five-minute intervals for 24 hours.

Photosynthetic activity in streams is one driver of diurnal cycles, which are characterized by repeating, predictable patterns. With sunlight as an energy source, aquatic vegetation produces carbohydrates by consuming carbon dioxide and producing oxygen as a byproduct. Diurnal monitoring shows that as soon as morning sunlight hits the water, the photosynthetic engine begins producing oxygen, which increases in concentration throughout the day (as water temperature and light intensity increase), until a peak in late afternoon. In the evening, energy from the sun diminishes and reduces photosynthesis. As plants use energy for metabolism but don't photosynthesize, they release CO₂ back into the water. The CO₂ reacts to form carbonic acid, thus lowering pH.

Diurnal monitoring also demonstrates seasonal effects. Daily cyclic patterns in temperature and pH that are strongly expressed in summer are dampened by cold temperatures and lower sun angles in winter (see figures below). In North Creek and other low-flow NCPN streams, summer peak temperatures and pH can exceed the water quality criteria for aquatic organisms. If extreme, these stressful effects can affect reproduction and even cause death.

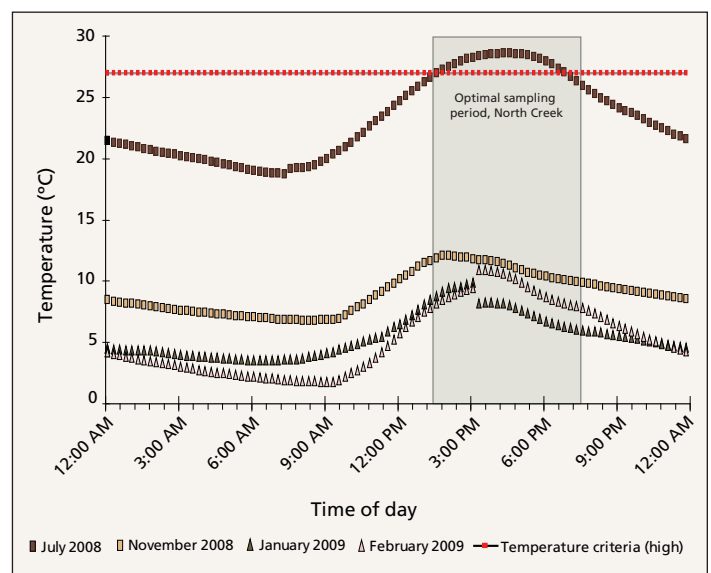
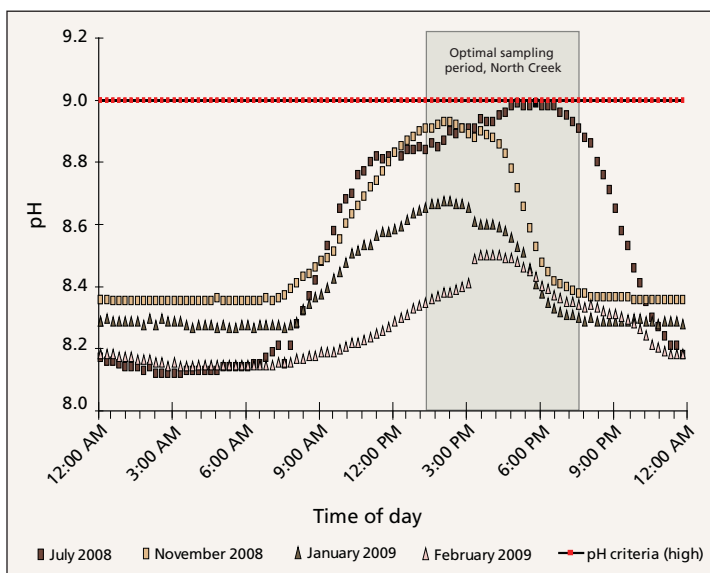


The Subway, Left Fork of North Creek, Zion National Park.

Based on diurnal monitoring in North Creek, it appears that sampling conducted between 1:30 and 7:30 p.m. would be most likely to document water quality criteria violations and best describe the stress on aquatic organisms that may be recurring on a daily basis. Other NCPN sites affected by high summer temperatures tend to be low-flow springs and pools in ephemeral washes. Larger rivers may also be subject to the same set of conditions—especially during drought years, when the diminished volume of water is more effectively heated by the sun. Understanding how parameters vary diurnally and seasonally will increase our ability to determine water quality status, detect long-term change, and identify criteria violations. All of this information will be used to help improve management of NCPN water resources.

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Effect of season and time of day on pH and water temperature in North Creek, Zion National Park. Monitoring at any time outside the window of 1:30 and 7:30 p.m. would not have captured the exceedances and near-exceedances that occurred.

Internet: <http://science.nature.nps.gov/im/units/ncpn/index.cfm>

Intranet: <http://www1.nrintra.nps.gov/im/units/ncpn/>