# Evaluation of Summer Macrohabitat Availability (temperature and water quality) for Aquatic Organisms in the North Fork Shenandoah River, Virginia

Jennifer Rohrer*, Don Orth, and Tammy Newcomb
Virginia Tech Department of Fisheries and Wildlife Sciences
jerohrer@vt.edu, dorth@vt.edu, newcombt@vt.edu

For more information please visit our website @ http://www.cnr.vt.edu/fisheries/North_Fork_Shenandoah

Figure 1. Area of NFSR with substantial algal growth and severe low flows (km 93.5).

## Abstract

- Water quality greatly affects the aquatic life a river can sustain. Ideally, flow rates, water temperature, dissolved oxygen (DO), and nutrients remain within acceptable limits for survival and growth even in anthropogenically influenced streams.
- North Fork Shenandoah River (NFSR) has been experiencing declining flow due to drought conditions and human population expansion requiring increased water withdrawals (Figure 1).
- The United States Geological Survey (USGS) sampled 52 NFSR sites in July 1999:
  - 11% of the sites exceeded Virginia's water quality standard for a maximum temperature of 31°C,
  - 35% were near the upper thermal limit for smallmouth bass, 25% exceeded the state standard for pH of 9.0,
  - 37% fell below the minimum dissolved oxygen standard of 4.00 mg/L, and
  - a high proportion of samples contained unionized ammonia ($NH_3$) levels above the estimated environmental threshold for mussels.
- To determine which areas are potentially inadequate for fish assemblages during low flow conditions, current habitat availability will be delineated, followed by modeling 14 reaches using **water quality prediction models.**

## Introduction

The Shenandoah watershed:

- spans approximately two million acres (3000 mi²), seven counties in Virginia and one county in West Virginia (UMD 2002).
- is comprised of three hydrologic units: the mainstem, the South Fork, and the North Fork (Figure 2).
- is known for an outstanding smallmouth bass fishery and provide important habitat for many fishes.
- is heavily used for drinking water, irrigation, industry, waste assimilation, hydroelectric power, and other economic uses.

## Methods

- Water quality data was obtained during 6 sampling trips at 10 sites along the NFSR from June 20 to August 8, 2002.
- Sampling began at the most upstream site, Cootes Store (km 141.8), at approximately 9:00 a.m. and continued downstream to Guard Hill (km 0), ending at approximately 3:30 p.m.
- DO, pH, Nitrogen-$NH_3$, Phosphate ($PO_4^{3-}$), and wet and dry temperature readings were recorded in the field using portable instruments and colorimetric tests.
- Data points were averaged over the months sampled.
- Error bars denote maximum and minimum values for each site (Figures 3-6).

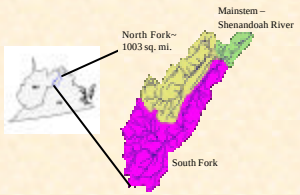


Figure 2. The Shenandoah River Basin (*Chan et al.* 2000).

## Conclusions

The development of water quality prediction models based on summer low flow conditions will be used to:

- Characterize macrohabitat availability (temperature and water quality) in the NFSR and is critical for water supply planning in the Northern Shenandoah Valley.
- Simulate alternative flows to show benefits and consequences of alternative flow levels on instream and offstream uses (See Figure 7).
- Eliminate or reduce effects of low flows such as rising temperatures, accelerated eutrophication and oxygen depletion.

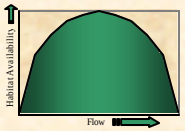


Figure 7. Water quality prediction models will estimate optimal flows for the NFSR to facilitate adequate habitat for aquatic organisms.

## ♦RESULTS♦

**DO level** fluctuations may be a result of:

- an abundance of submerged aquatic vegetation farther upstream,
- measurements taken throughout the day, and
- substrate composition (i.e. bedrock, cobble, silt).

- Virginia state **maximum standard pH of 9.0** was exceeded by two sites.
- **Un-ionized Ammonia ($NH_3$) levels** are high throughout the entire NFSR watershed.
- Combined, high **temperature** and **pH** values cause potentially toxic levels of $NH_3$ to aquatic organisms (Figure 5) (Mummert 2001).
- At lower temperatures and pHs, ammonia is found in the non-toxic form of the ammonium ion ($NH_4^+$), which can be used in nitrification reactions under aerobic conditions by autotrophic bacteria (Wetzel 1975) and is not a threat to fishes.

- **Phosphates** are limiting nutrients in freshwater systems.
- Phosphates from fertilizers, poultry plants, and cow pastures are major factors in the presence of algal blooms, which ultimately decrease oxygen levels and can create fish kills.
- Levels were found to be above EPA recommendations of 0.1 mg/L total P.

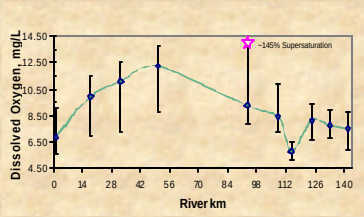


Figure 3. Average DO Levels in NFSR, 6/20/02 – 08/08/02.

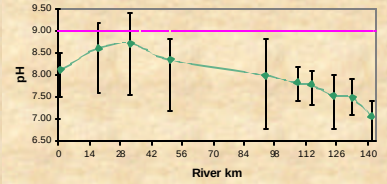


Figure 4. Average pH Levels in NFSR, 06/20/02 – 08/08/02.

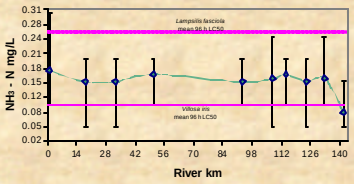


Figure 5. Average $NH_3$ Levels in NFSR, 06/20/02 – 08/08/02.

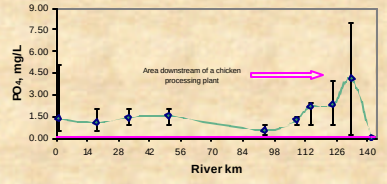


Figure 6. Average $PO_4^{3-}$ Levels in NFSR, 06/20/02 – 08/08/02.

## Acknowledgements

Northern Valley Regional Commission Technical Committee, Virginia Tech, United States Geological Survey (USGS), Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Department of Environmental Quality (DEQ), Dr. Steve Cox and Dr. Marc Edwards, Virginia Tech Civil and Environmental Engineering Department