Using PHABSIM Modeling to Identify Conservation Thresholds in the North Fork Shenandoah River, Virginia

Adrienne W. Averett, Jason Persinger, and Donald J. Orth

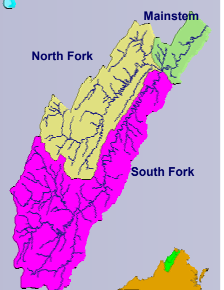
Virginia Polytechnic Institute and State University, Department of Fisheries and Wildlife Sciences, 100 Cheatham Hall (0321), Blacksburg, Virginia, 24161, Phone: 540-231-5573, aweimer@vt.edu, jpersing@vt.edu, dorth@vt.edu

ABSTRACT

The North Fork Shenandoah River Valley is facing many challenges concerning its freshwater supply. The Valley is a drought prone area. Since 1998, dry winters have failed to recharge groundwater supplies, resulting in severe hydrologic drought conditions. Population growth in the North Fork Corridor has averaged a 20.4% rate of increase since 1970. With the Valley's rural setting and close proximity to the Washington D.C. Metro area, further growth is inevitable. Current projections of future population growth and water demand predict that water use will exceed supply by 2025. In 1999, a four-year instream flow study was initiated to evaluate the hydraulics, habitat, and water quality of the North Fork Shenandoah during low flow conditions. Using the Instream Flow Incremental Methodology (IFIM), Virginia Tech in cooperation with the United States Geological Survey (USGS) collected hydraulic, fish habitat, and water quality data throughout the basin. Hydraulic and fish habitat data were analyzed using Physical Habitat Simulation (PHABSIM) software. Model results will provide biologists, water managers, county planners, and stakeholders with baseline information to identify conservation thresholds and institute conservation flow regulations.

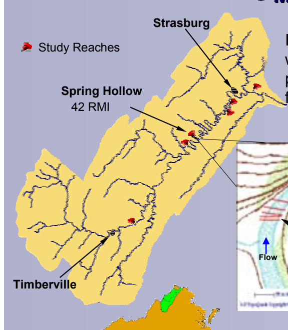
INTRODUCTION

- The North Fork Shenandoah River supplies only 20% of the mainstem discharge, yet received 60% of the Shenandoah Basin population growth from 1980 to 1990.
- The basin provides many benefits (economic, recreational and biological) to residents and visitors of the Shenandoah Valley.
- Frequent droughts contribute to reduced water quality and fish kills.
- Conflicts are escalating over instream and offstream uses and future water availability.
- Model output will provide conservation flow scenarios and aid water allocation management.

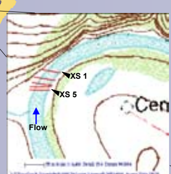


The Shenandoah River Watershed.

METHODS

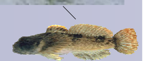


In June 2000, 6 study reaches were chosen within the North Fork Basin to characterize the physical stream. The Spring Hollow site is the focus of this presentation.



The site is 228 ft in length and comprised of 1 run cross section (XS 1), and 4 riffle cross sections (XS 2 – 5). The substrate is dominantly bedrock and cobble.

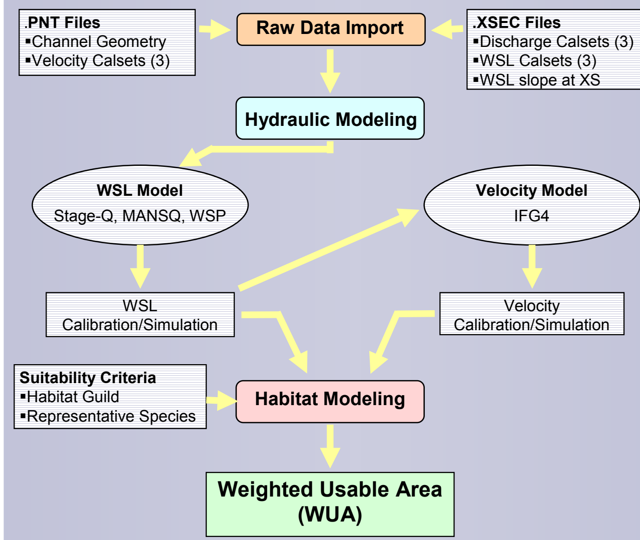
Looking upstream from XS 1, the dashed yellow line marks the location of XS 5. From June 2000 to March 2001, channel geometry and hydraulic variables (for 3 target flows) were measured at each cross section. During summer 2002, fish habitat data were collected for representative species and habitat guilds via throwable-anode electrofishing.



Habitat criteria were developed for four habitat guilds: riffle, fast generalist, pool - run, and pool - cover. The longnose dace (*Rhinichthys cataractae*) and mottled sculpin (*Cottus bairdi*) are riffle guild representative species.

METHODS, CONTINUED

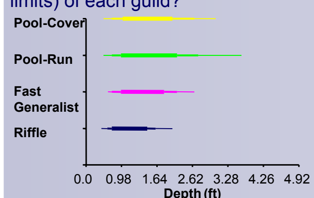
- Data were analyzed using the following process in **PHABWIN2002**.

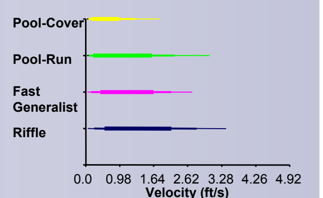


- Using a step-wise process, WUA graphs were examined for conservation triggers.

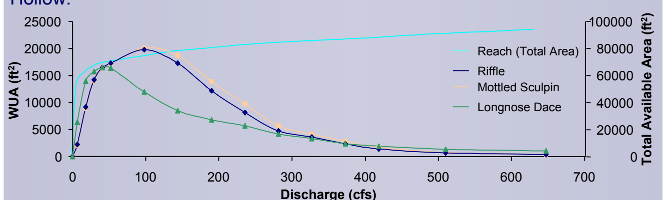
RESULTS

Focusing on depth and velocity, what are the habitat needs (90% tolerance limits) of each guild?

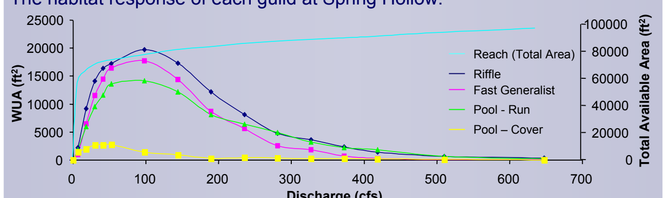




The habitat response of the riffle guild and its representative species at Spring Hollow.



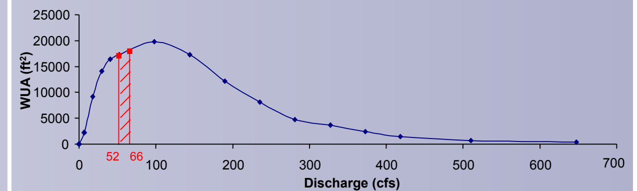
The habitat response of each guild at Spring Hollow.



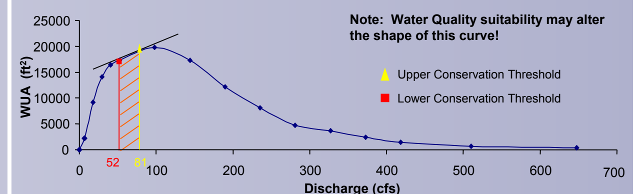
CONCLUSIONS

- Habitat analysis for the pool - cover guild and its representative species is not useful for establishing conservation thresholds.
- Riffle habitats constitute critical areas during low flow conditions as water depletion and decreased water quality forces its inhabitants, like the longnose dace and mottled sculpin, into sub-optimal areas (runs and pools).
- Using the riffle guild habitat response as a model, we propose the following process for conservation threshold identification:

1. Plot the low flow statistics on the riffle WUA – Q curve. We used the Strasburg Gauge 7Q10 – 7Q30 from Longanathan et al (1985) for example.



2. Calculate the slope of the WUA – Q curve to the lower threshold (7Q30) and fit the tangent of the slope to the curve. This point represents the upper conservation threshold.



3. Based on the conservation thresholds, establish a Water Management Conservation Alert System with associated restrictions:

- Conservation Advisory = water watch; Phase I restrictions.
- Conservation Warning = expected biological stress; Phase II restrictions.
- Conservation Emergency = severe biological stress; Phase III restrictions.

- The previous steps outline an iterative process, in which stakeholder groups are an active part of water management planning and decision making.

FUTURE WORK

- Finalize substrate index criteria for guilds and representative species.
- Run combined habitat suitability criteria (depth, velocity, substrate index) through habitat model for all study reaches.
- Run Time Series analysis for all study reaches.
- Complete macrohabitat (water quality and temperature) analysis and modeling.
- Analyze Strasburg Gauge streamflow data and generate current low flow statistics for period of record (1925 – 2002).
- Finalize conservation threshold identification process.
- Present model results (PHABWIN, QUAL2E, SNTEMP) and conservation threshold identification process to North Fork Shenandoah Technical Advisory Committee.

ACKNOWLEDGEMENTS

- Northern Shenandoah Valley Regional Planning Commission.
- Virginia General Assembly for funding this study.
- Donald Hayes and Jennifer Krstolic, USGS