Determining Ecological Flows for River Basin Planning in North Carolina

Water Allocation Research Seminar
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Presentation Overview

- Background – Instream & Offstream Uses
- Minimum Flows & Flow Regimes
- Site Specific Habitat Studies & Instream Flow Requirements – what we do now
- Target Ecological Flows for River Basin Planning
- NC Hydrologic Stream Classification
- Eno River Pilot Study

Instream Flow Needs

- **What For?** - *to maintain instream uses*
- **Amount** *(cfs = 1.546 x mgd)*
- **Location** – *habitat type, species of interest, drainage area, tributary inflow*
- **Time** – *monthly / seasonal / inter-annual variation in water availability, critical life stages, recreation season*

Instream Uses

Water needs to remain in the channel for:

- Aquatic Habitat
- Water Quality
- Recreation
- Other – e.g. channel morphology, temperature regime, salinity, wetlands maintenance, aesthetics

Instream Flows Provide Habitat for a Diversity of Organisms

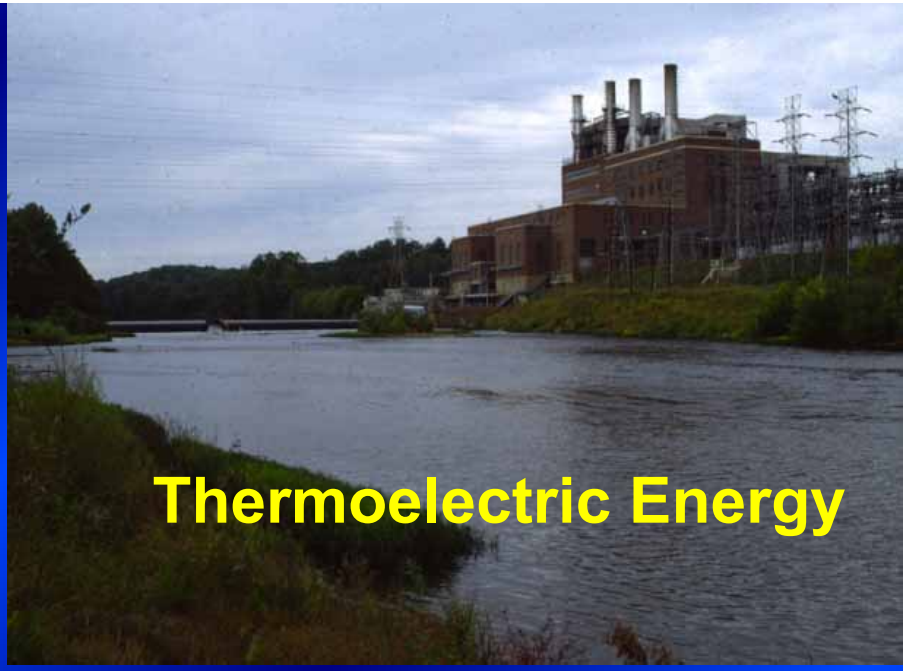
Flow Makes a Difference

Offstream Uses

Require water to be removed from the channel

- **Consumptive – permanent removal**
- **Bypass - temporary removal**

Water Supply



Thermoelectric Energy

Agriculture

Hydropower diversion

As population increases, so do offstream uses

Pressures on instream flows and instream uses also increase

SOME TERMINOLOGY

- Minimum flow
- Flow regime
- Ecological flow
- Instream flow requirement
- Target planning flow

Minimum Flows

- Minimum flows are just that – a minimal threshold intended to maintain aquatic life for relatively short periods of time
- The lower the minimum flow – the more it is suited only to allow survival for brief periods
- Ecosystems suffer when the minimum flow becomes THE flow for extended periods.

Flow Regime

- Incorporates the following components:
  - magnitude
  - timing
  - frequency
  - duration
  - rate of change
  - retains some degree of natural stream flow variability

Ecological Flows

- Federal Clean Water Act – Declaration of Goals and Policy SEC. 101. (a) "The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

- Maintain ecological integrity – biological, chemical & physical - "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat." [1]

[1] Karr, J.R. and D.R. Dudley. (1981). Ecological Perspectives on Water Quality Goals. Environ. Manage. 5:55-68

Instream Flow Requirement

- A site-specific, project-specific determination
- Developed during preparation of environmental documents and permit reviews
- Incorporated in permits for water resource projects – FERC, 401/404, Dam Safety, EA/FONSI or EIS, CUA

Site- and Project–specific Evaluations

Field Study

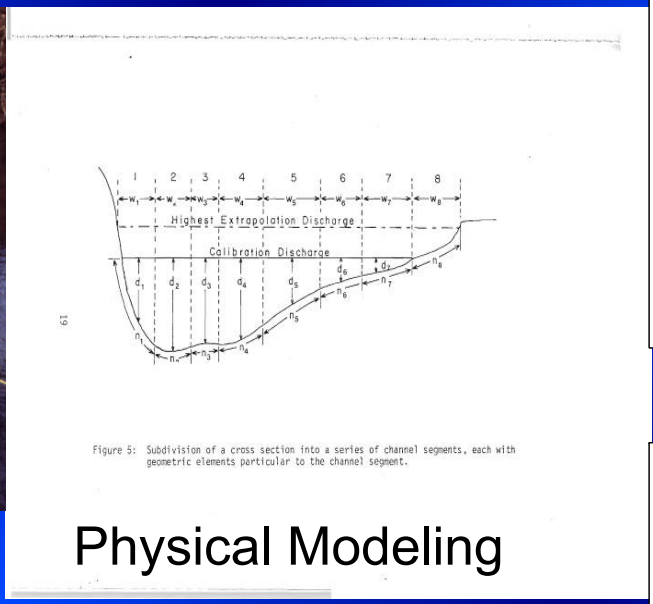
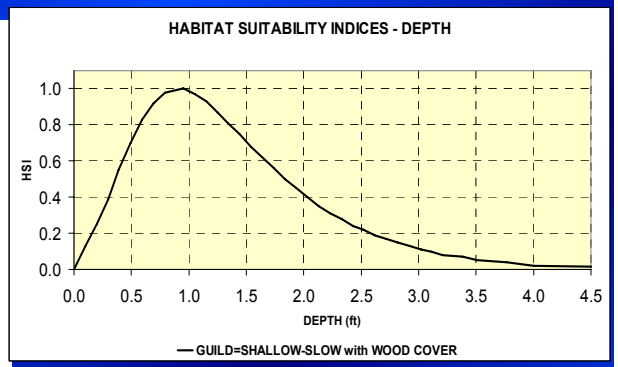
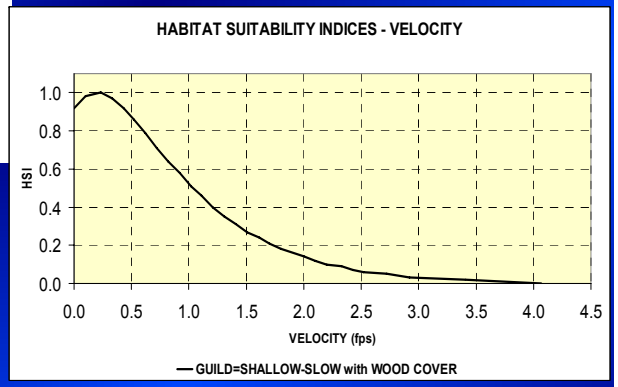


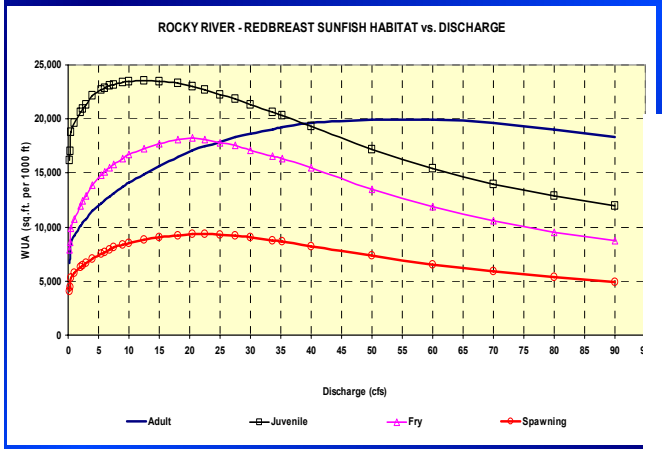
Figure 5: Subdivision of a cross section into a series of channel segments, each with geometric elements particular to the channel segment.

Physical Modeling

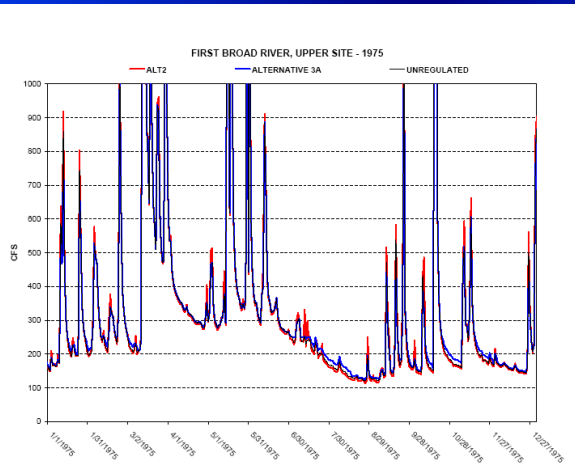


Habitat Modeling





Habitat vs. Flow
for each organism



Hydrologic Modeling

- Time Series Analysis
- Flow Alternatives
- Recommendations

Requires time and $

Target Flows Used for River Basin Planning

- If not included in the basin model, the underlying assumption would be that all flow in the stream – aside from any existing, specific project-related flow requirements – is available for withdrawal.

- Ecological planning flows are NOT intended to replace in-depth, site-specific studies for particular water project proposals – especially those larger projects with more complex environmental concerns.

River Basin Approach for Long-range Planning

- Numerous locations throughout a basin
- Wide variety of streams – sizes, types
- One-size fits all approach to ecological flows for the entire state is not appropriate for North Carolina's diversity of rivers and streams
- Field studies at every location are not practical

River Basin Approach for Long-range Planning

- The offstream component is already quantified in the model, using existing water use data and projected increases

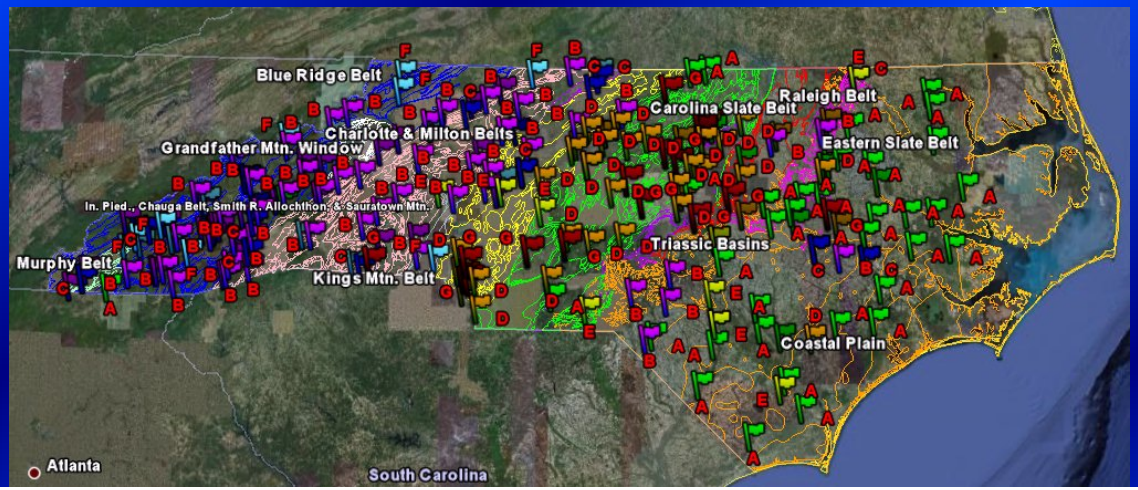
- For planning purposes, how do we quantify the instream component? – to evaluate water availability now and in the future – instream and offstream

The First Step: Developing a Hydrologic Stream Classification System

- Hydrologic differences result in ecological differences
- Sorting streams by hydrology also sorts into ecologically distinct types
- DWR, WRC and EDF worked with EFS to develop a hydrologic stream classification system for NC

Hydrologic Stream Classification System for NC

- Based on 231 USGS gages with at least 18 years of record
- Distinguished between relatively unaltered and significantly altered gage records
- Examined 108 hydrologic variables, identified 22 critical
- Can analyze USGS records or model output



StreamFlow

A Stream Analysis And Environmental Flow Assessment System For North Carolina

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

n.c.denr
North Carolina Department of Environment and Natural Resources

NC Hydrologic Stream Classification Workshop – December 2009

- Aquatic ecology and hydrology experts from DWR, WRC, DWQ, NHP, USGS, USFWS, NRCS, EDF, and EFS
- Introduction to classification analysis and software
- Review of classes – sub-dividing, naming
- Future demonstration project

Stream Classes for NC

A. Coastal Streams

B. Small Stable Streams – cool & cold water

C. Large Stable Streams

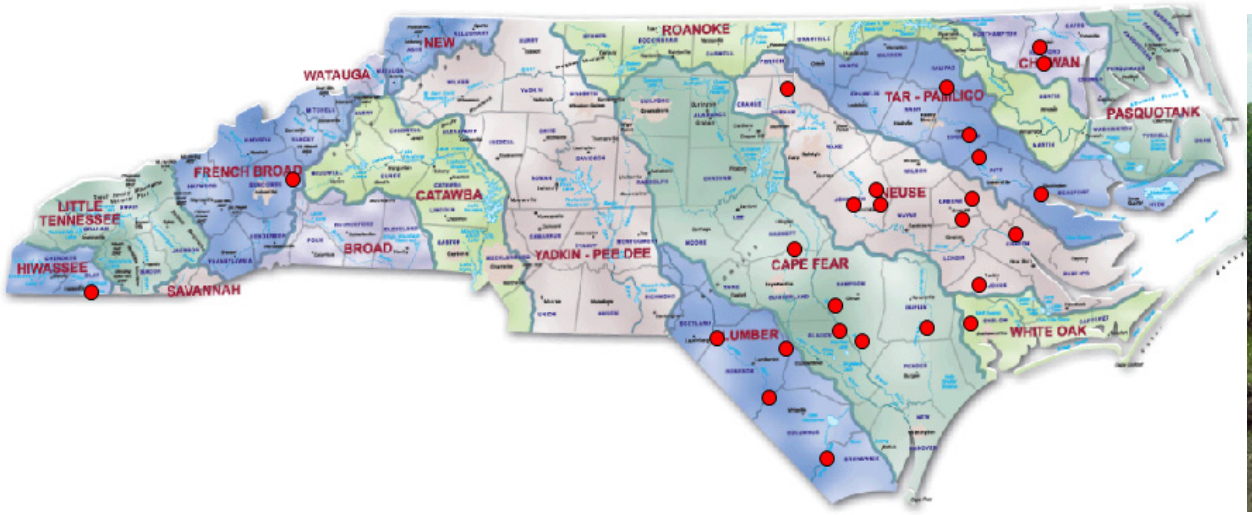
D. Small Flashy Streams –
natural & accidental

E. Large Piedmont Rivers

F. Medium Stable Streams – cool & warm water

G. Small Seasonal Streams –
natural & accidental

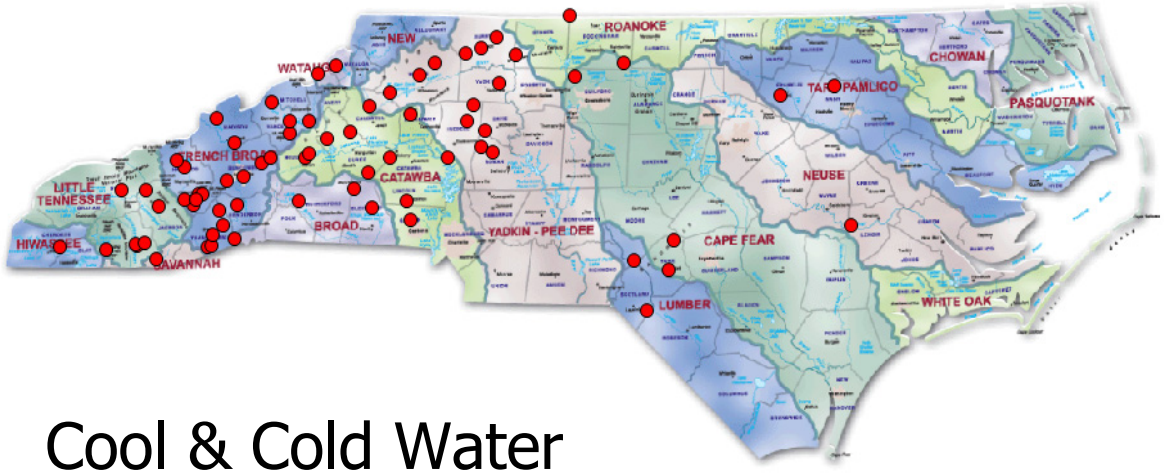
A. Coastal Streams



South River

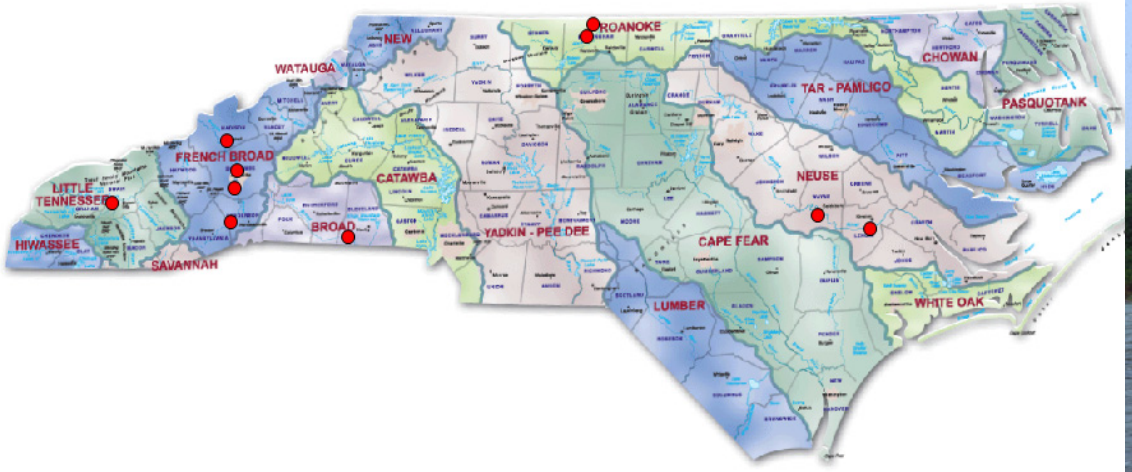
Ivy River

B. Small Stable Streams



Cool & Cold Water

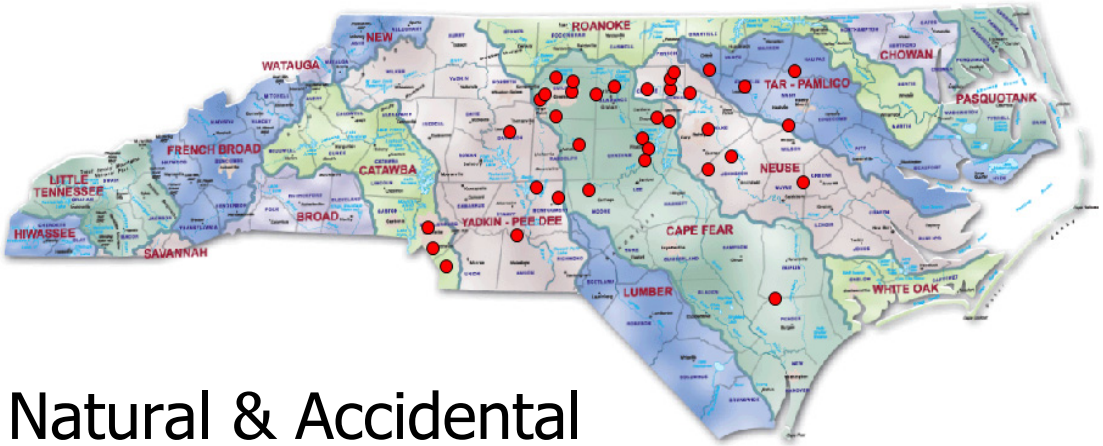
C. Large Stable Streams



French Broad River

D. Small Flashy Streams

Eno River

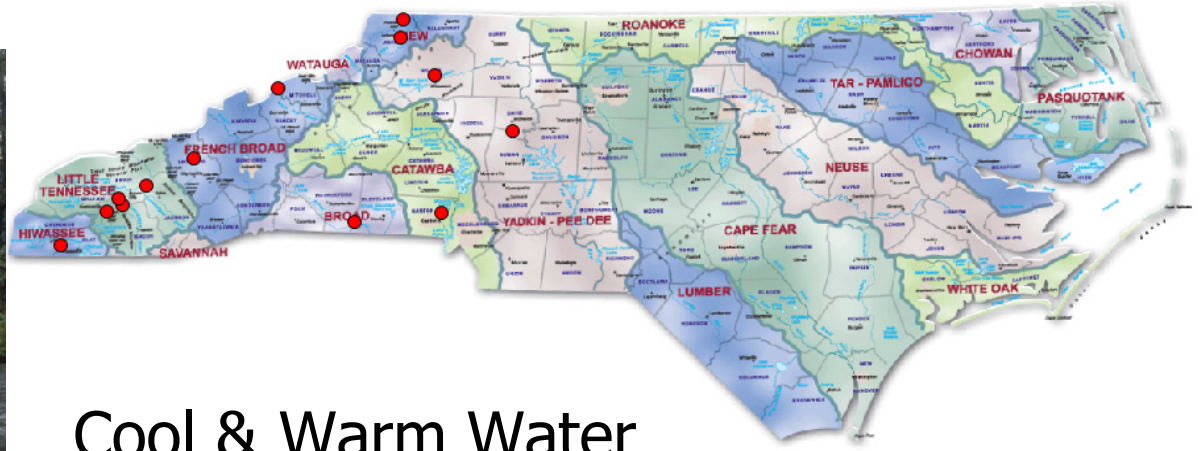


Natural & Accidental

E. Large Piedmont Rivers

Cape Fear River

F. Medium Stable Streams



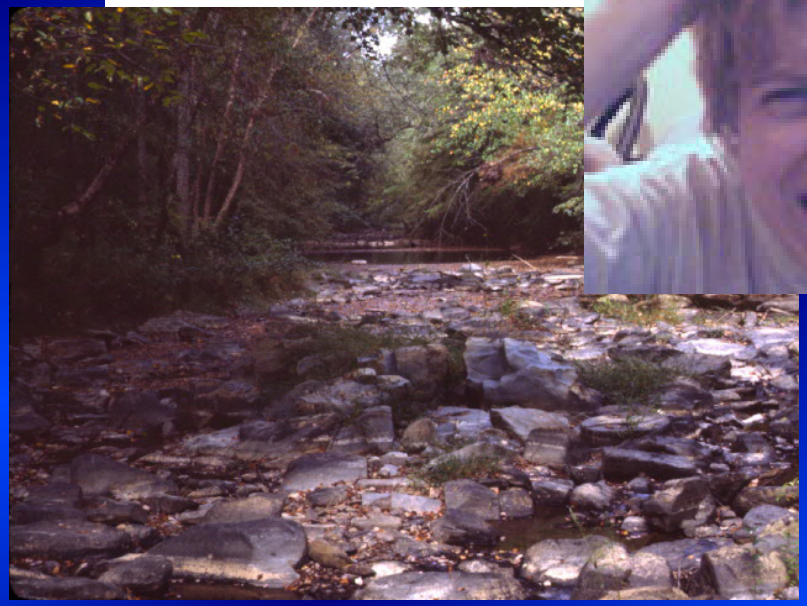
Tuckasegee River

Cool & Warm Water

G. Small Seasonal Streams

But what does this have to do with Ecological Flows?

Natural & Ac



0 cfs **Big Bear Creek** **32 cfs**

Why Classify?

- Different types = different habitat = different ecological communities = different flow needs
- Ultimately – develop a specific technical approach for determining ecological planning flows for each of the 11 stream classifications
- Where USGS stream flow data is lacking, river basin hydrologic models will be used to simulate a record of daily stream flows that can then be analyzed with the stream classification software to determine the hydrologic classification

The Next Step: Eno River Demonstration Project

Eno River Demo

- A pilot project
- Eno River – Hillsborough and State Park sites
- Neuse River Basin Hydrologic Model
- Existing Habitat Models (updated)
- Evaluate the effects of different flow management approaches on aquatic habitat
- Is this technique viable for developing approaches for other stream classifications and other basins?

Some Potential Alternate Flow Management Approaches

- Minimum flows
- Setting a flow target that varies seasonally or monthly, and allowing some variation within bounds above and below this target.
- Setting the threshold for allowable hypothetical withdrawals as the amount that results in a change in the hydrologic stream classification
- Percentage of inflow available for withdrawal – may vary by season, include drought protocol with higher percentage withdrawal
- Other approaches suggested by the analysis

Rivanna River - Charlottesville, VA [2]

- Case study: meeting 50-yr water supply demands and ecosystem needs
- 56% increase in demand by 2055
- Three-pronged strategy
  - Enlarge reservoir
  - 3-stage drought management plan
  - Probalistic forecasting triggers conservation

Rivanna River Example

- Under the new water supply plan, environmental flow releases from South Fork Reservoir will:
  - Range from 70–100% of natural inflow at least 90% of the time,
  - Dropping to 30–50% of natural inflow only during extreme droughts.
  - These environmental flow releases will substantially restore natural flow variability, as compared to the static environmental flow releases provided historically.

[2] Richter, B. D., and G. A. Thomas. 2007. Restoring environmental flows by modifying dam operations. *Ecology and Society* 12(1): 12. [online] URL: http://www.ecologyandsociety.org/vol12/iss1/art12/

Advisory Group

Science Advisory Board

Scientific-Technical Workgroup

Policy-Implementation Workgroup

[3] From Charlottesville City Council Work Session: Community Water Supply Plan 5/6/08 Ridge Schuyler, Director, Piedmont Program, The Nature Conservancy

Questions?

http://www.ncwater.org/Data_and_Modeling/eflows/