# Determining Ecological Flows for River Basin Planning in North Carolina

*Ecological Flows Science Advisory Board*
*Raleigh – November 8, 2010*

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# 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

# 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."**

- **Ecological flow – "the stream flow necessary to protect ecological integrity". [1]**
- **Ecological integrity – "the ability of an aquatic system to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to prevailing ecological conditions and, when subject to disruption, to recover and continue to provide the natural goods and services that normally accrue from the system". [1]**

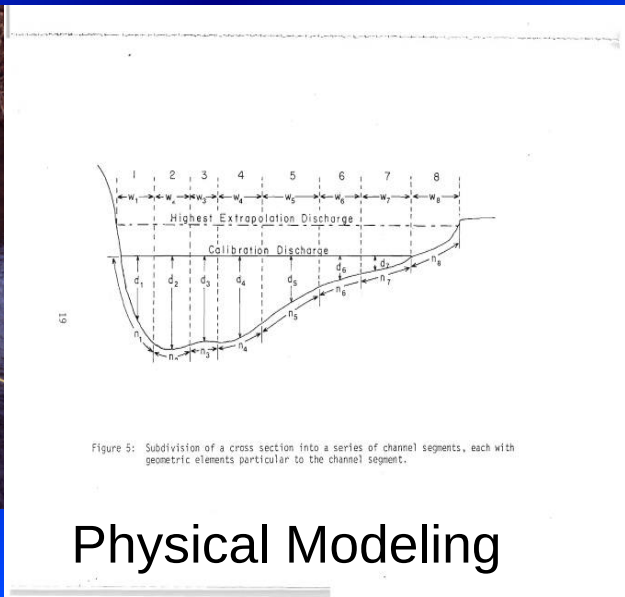
[1] North Carolina **General Assembly Session 2009 – House Bill 1743 Ratified Bill**

# Instream Flow Requirement

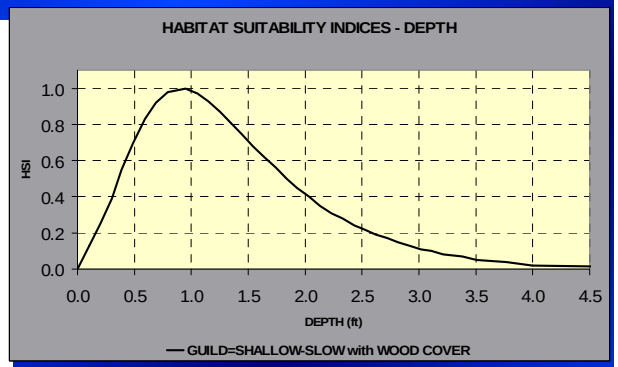
- A site-specific, project-specific determination
- Developed during preparation of environmental documents and permit reviews
- Incorporated in permits for water resource projects – FERC, 401/404, Dam Safety, EA/FONSI or EIS, CUA

# Site- and Project–specific Evaluations

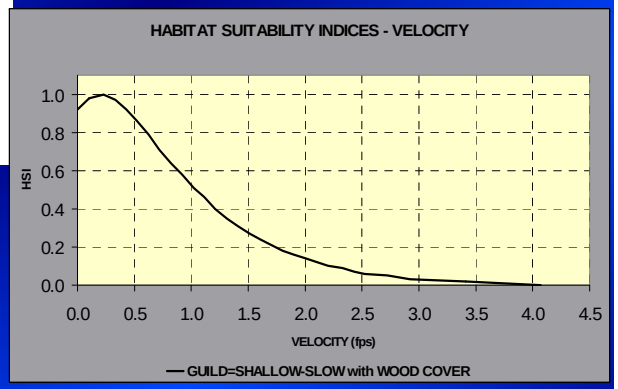
Field Study

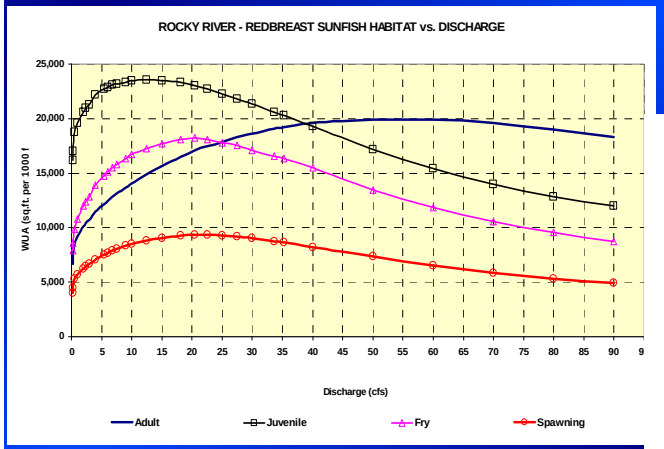



Physical Modeling

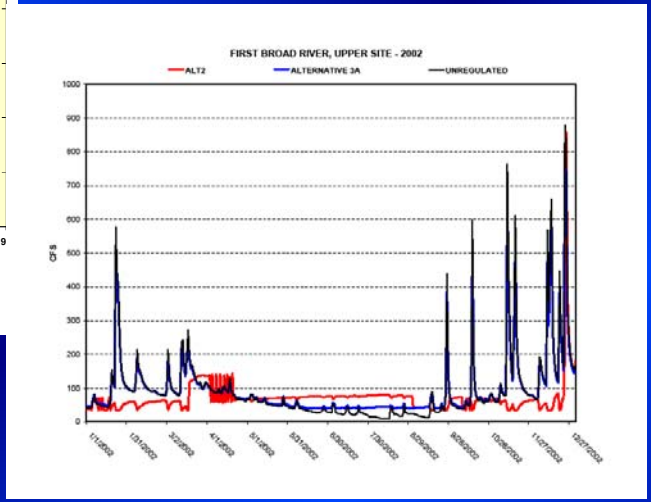



Habitat Modeling




Habitat vs. Flow
for each organism




Hydrologic Modeling

- Time Series Analysis
- Flow Alternatives
- Recommendations

**Requires time and $**

# Target Flows Used for River Basin Planning

- **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.**

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

# 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

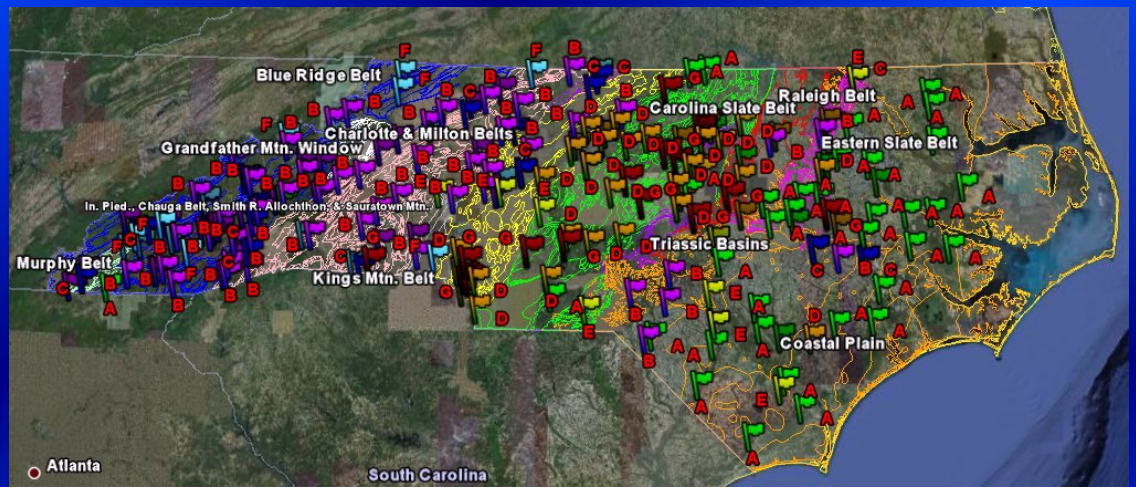
- For planning purposes, how do we quantify the instream component? – to evaluate water availability now and in the future – instream and offstream

# 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

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EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

ncdenr
North Carolina Department of Environment and Natural Resources

# Stream Classes for NC

A. Coastal Streams

B. Small Stable Streams – cool & cold water

C. Large Stable Streams

D. Small Flashy Streams –

natural & accidental

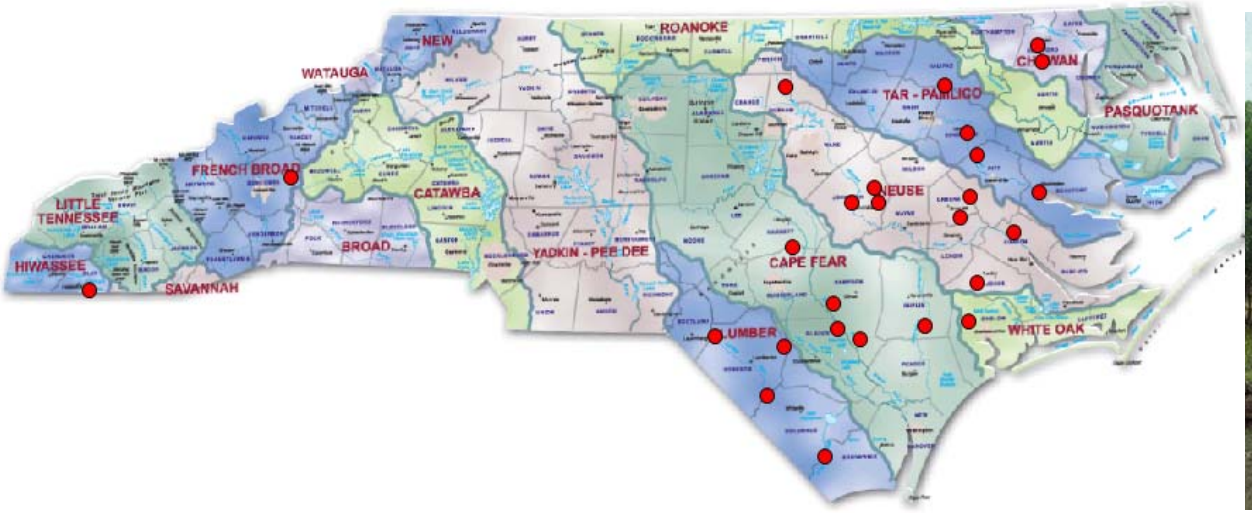
E. Large Piedmont Rivers

F. Medium Stable Streams – cool & warm water

G. Small Seasonal Streams –

natural & accidental

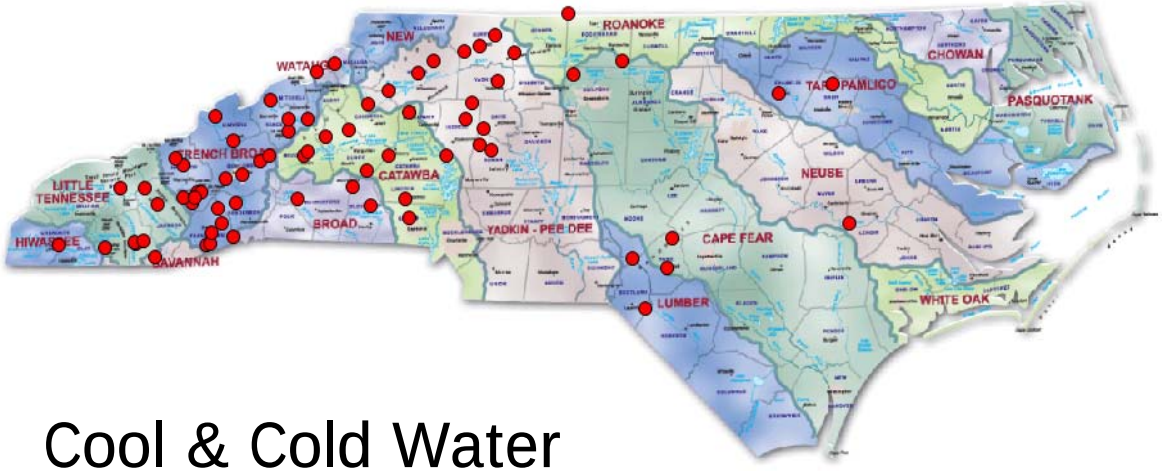
## A. Coastal Streams




**South River**

**Ivy River**

## B. Small Stable Streams

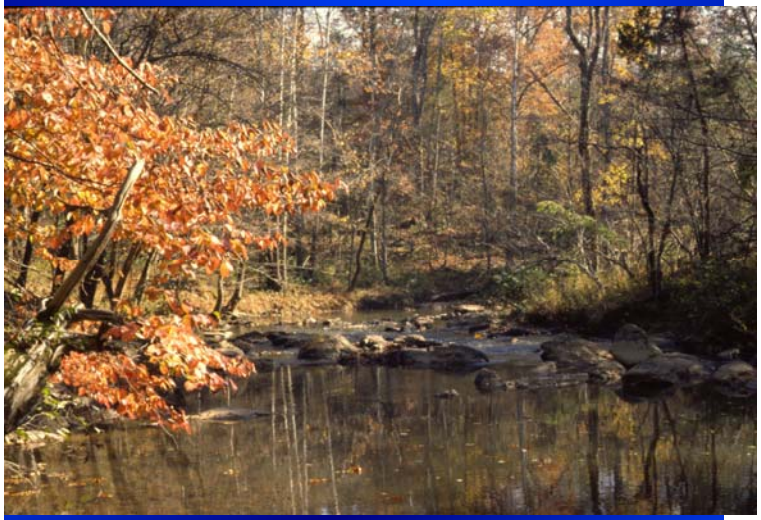



Cool & Cold Water

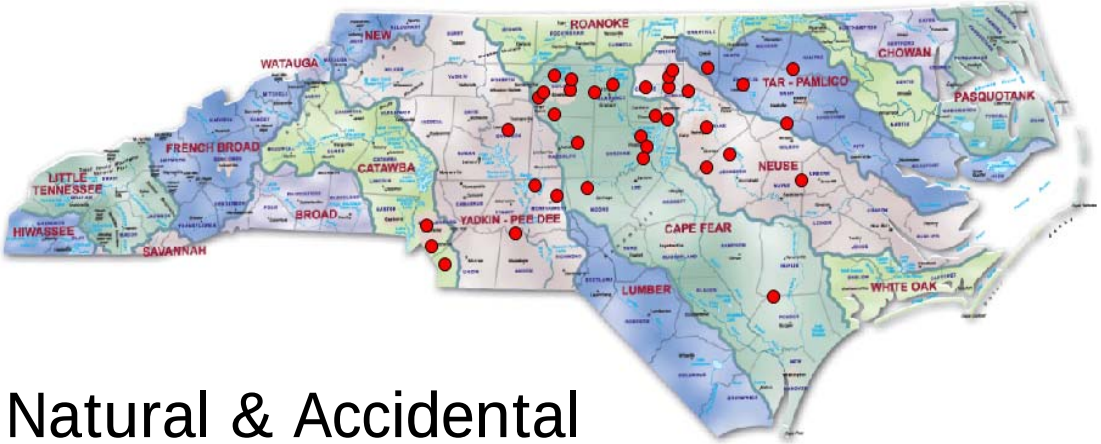
## C. Large Stable Streams

**French Broad River**

**Eno River**



## D. Small Flashy Streams




Natural & Accidental

## E. Large Piedmont Rivers

**Cape Fear River**

## F. Medium Stable Streams

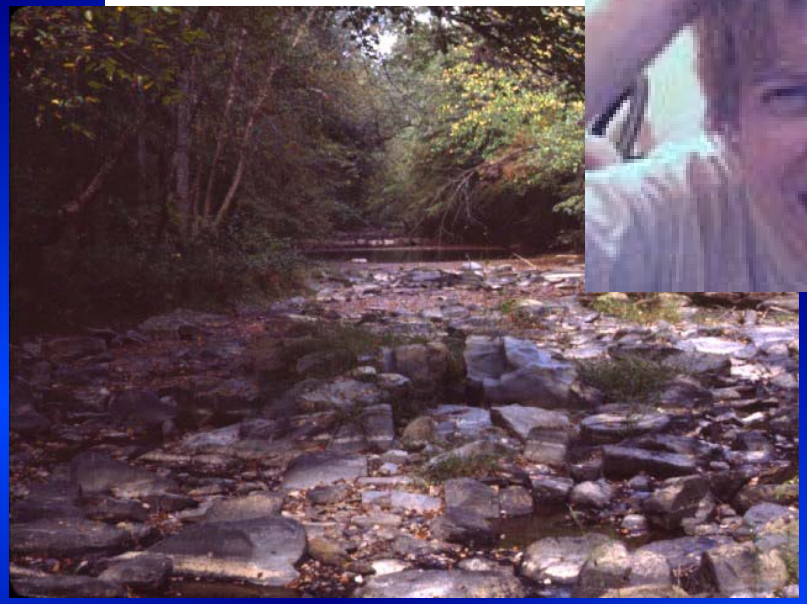
**Tuckasegee River**

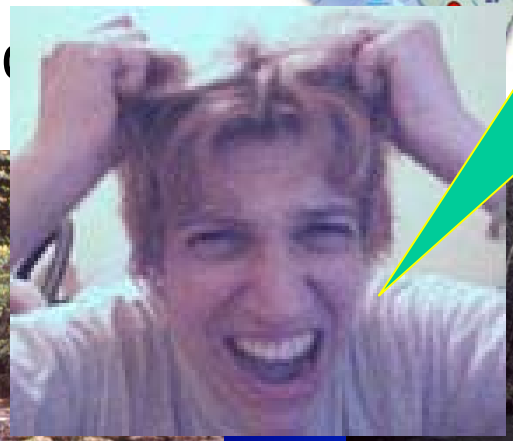
Cool & Warm Water

# 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

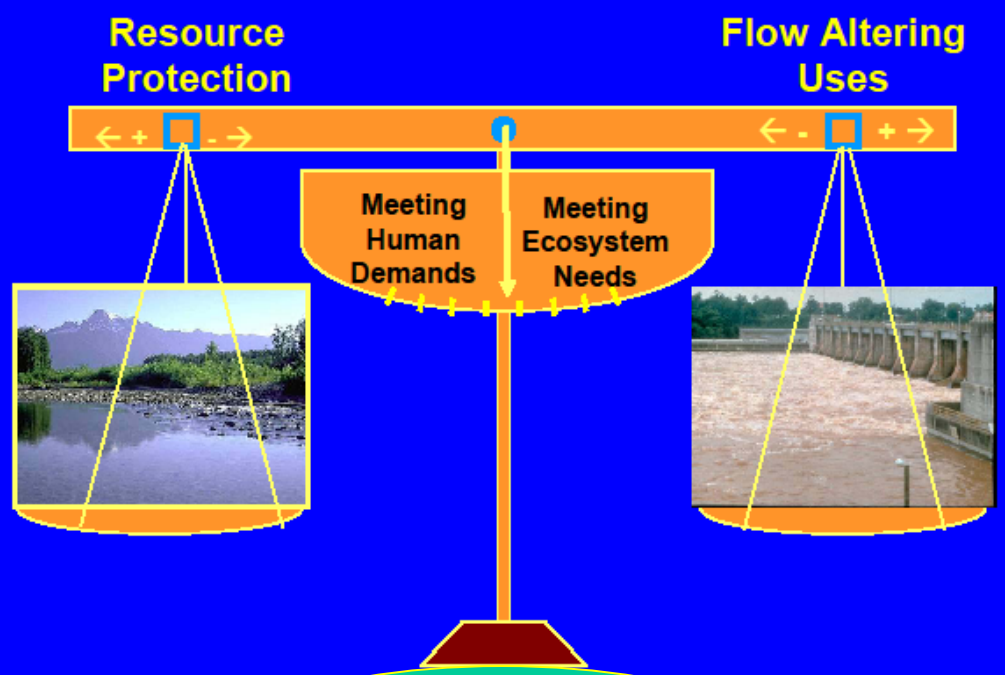
# Eno River Demo

- A <u>pilot</u> 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.
- Percentage of inflow available for withdrawal – may vary by season, include drought protocol with higher percentage withdrawal
- Setting the threshold for allowable hypothetical withdrawals as the amount that results in a change in the hydrologic stream classification
- Other approaches suggested by the analysis

# Finding the Balance[3]




**Advisory Group**

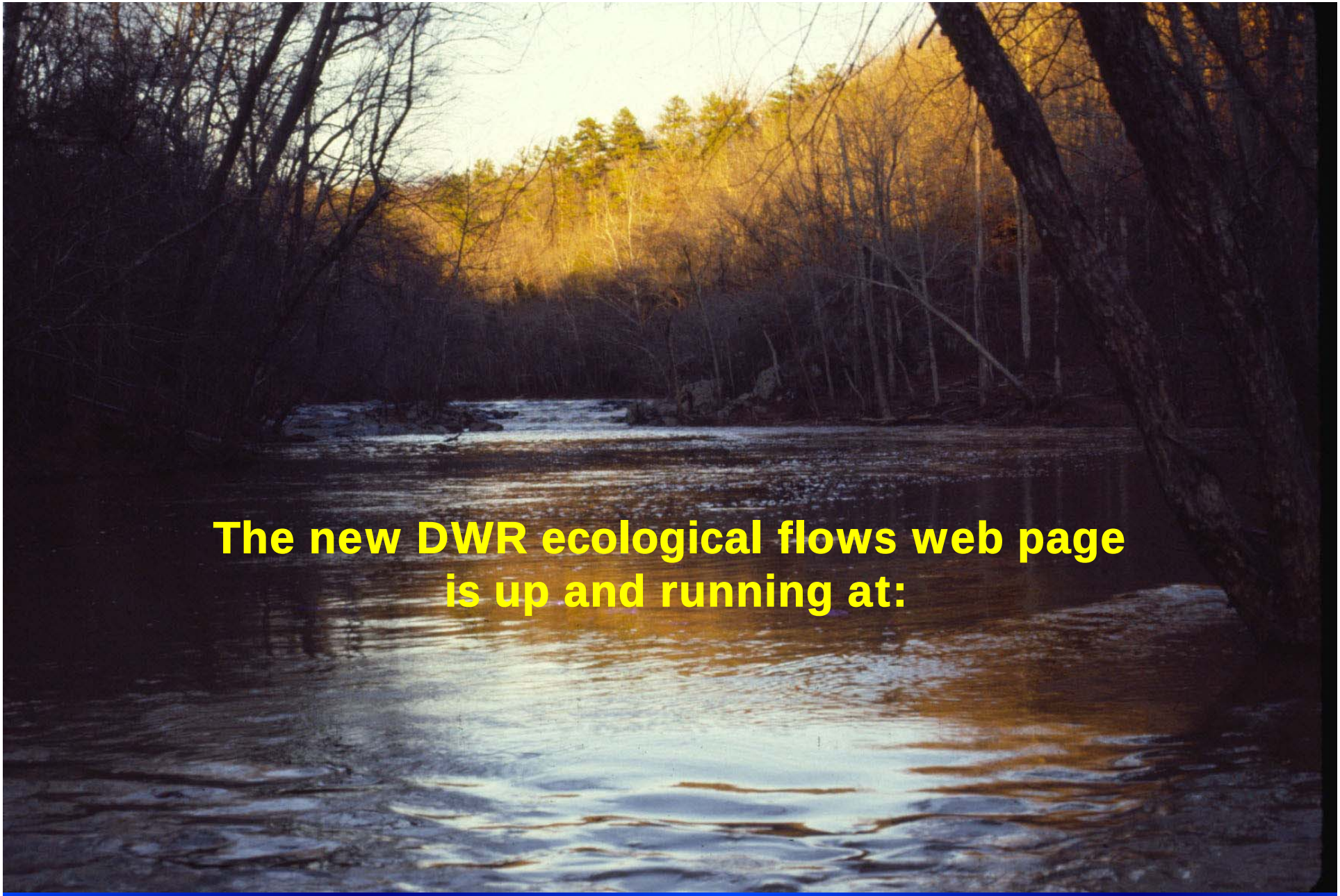
Science Advisory Board

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/**