Determining Ecological Flows for River Basin Planning in North Carolina

Water Allocation Research Seminar
Raleigh - June 29, 2010

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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 \((cfs = 1.546 \times mgd)\)
• 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
Roanoke River

Flow Makes a Difference

Cheoah River
Offstream Uses

Require water to be removed from the channel

- Consumptive – permanent removal
- Bypass - temporary removal
Water Supply

Agriculture

Hydropower diversion

Thermoelectric Energy
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.”

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

Habitat Modeling

Physical 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

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• 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

B. Small Stable Streams

South River

Ivy River

Cool & Cold Water
C. Large Stable Streams

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 & Accidental

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

- 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
  - Probabilistic 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.

Charlottesville City Council Work Session: Community Water Supply Plan

May 6, 2008

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Advisory Group

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
The new DWR ecological flows web page is up and running at:

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