Middle Potomac River Watershed Assessment: Sustainable Flow and Water Resource Analysis

First of a six-part webinar series
April 12, 2011

Please stand by, the webinar will start momentarily.
Middle Potomac Watershed Assessment
Webinar 1: Technical Overview

Speakers

Stephanie Flack, Potomac River Project Director, MD/DC Chapter of The Nature Conservancy

Carlton Haywood, Director for Program Operations, ICPRB
To develop information and tools that enable the Potomac watershed jurisdictions to protect environmental flows, which are defined as the seasonally variable flows of water that sustain healthy river ecosystems and the goods and services that people derive from them.
Benefits of basin-wide environmental flows assessment

Each of the Potomac basin jurisdictions is developing or planning for some sort of environmental flows assessment. Shared drivers are:

- Ensure water supply adequate for population growth
- Protecting ecological resources and promoting environmental sustainability
- Improved preparedness for periodic droughts
- Respond to water quality and quantity issues arising from Marcellus shale gas

Benefits of basin-wide environmental flows assessment

- Watershed approach
- Consistent methodology basinwide: tools and information for all jurisdictions
- Fill historic gap in considering inter-jurisdictional impacts of water use
Cost-shared project:
• 75% Federal (USACE) funding through Energy and Water Act
• 25% funding from non-Federal funding sponsor = TNC
• Technical partner = ICPRB
• Additional support from NPS, other agencies

Total project cost  $1.2M

Project timeline:
Start  May 09
Complete  Jun 12
Two methodologies

1) Small streams
   - An adaptation of the Ecological Limits of Hydrologic Alteration (ELOHA) approach (Poff et al, 2010)
   - Estimate current and future human water uses and watershed impacts on flows
   - Quantify relationships between flow alteration and aquatic ecosystem health
   - Provide baseline information and analyses to support water use decision making

2) Large rivers
   - Flow-ecology hypotheses developed for key species from literature review and expert judgment
   - Hypotheses translated into flow component needs
   - Flow statistics identified for flow components, and calculated
   - Review with stakeholders
Project Timeline

2009

May – Project start
Sep – Project Overview Webinar (recording on project website)

2010

Sep – Large River Flow Needs Workshop

2011

Apr – (anticipated) Large River Flow Needs Final Report
Apr-Oct – Webinar series to explain project to stakeholders and get input
Nov - Final project workshop: potential policy & mgmt. applications

2012

Feb – Final report delivered to COE
Large River Flow Needs Study

- Literature review / expert assessment of ecological needs
- Flows analysis
- Stakeholder workshop
- Final Report

Outcomes
- High inter- and intra-annual variability in flows
- No documented negative ecological impacts from flow regime
- ID Information gaps
- Pending more info, current flows be maintained
- Workgroup to follow-up
### Technical details on methodology for small streams
- Obtain feedback from stakeholders
- Prepare for concluding workshop: focus on management applications

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**Hydrologic Foundation**

- Build hydro model, delineate watersheds
- Simulated flows for baseline, current, and future scenarios

**River Classification**

- Select (first cut) river types based on natural and anthropogenic factors
- Final river types

**Flow-Ecology Relationships**

- Explore relationships between biometrics, stream habitat, and land/water uses
- Subset of biometrics most sensitive to flow alteration
- Flow alteration - ecological response relationships for each river type

**Decision Making**

- Implementation
- Recommendations for Environmental Flow Standards
- Acceptable Ecological Conditions
- Societal Values and Mgmt Needs

**Flow Alteration**

- Baseline-to-current and current-to-future flow alteration
- Sensitive measures of flow alteration

Monitor flows, biology, habitat, water quality, water uses, and land uses

Adaptive Adjustments

Monitoring: Necessary data sets

Project is built on an existing foundation of data

- Gaged stream flows
- Benthic macroinvertebrate samples
- Stream habitat data
- Water withdrawals locations and amounts
- Land use/land cover
- Impoundments
Hydrologic Foundation – Flow Model

• HSPF (Bay Watershed Model)
• Additional segments to accommodate significant impoundments
• Calibrated at 56 gaged locations
• Flows simulated for 713 delineated watersheds using WOOOMM model

Jun 16 webinar: about modeling and the hydrologic foundation.
Watersheds with biological sample points selected for flow simulation

574 watersheds < 38.6 sq. mi.
Watersheds with biological sample points selected for flow simulation

92 watersheds between 38.6 and 200 sq. mi.
Watersheds with biological sample points selected for flow simulation

40 watersheds between 200 and 1,000 sq. mi.
Watersheds with biological sample points selected for flow simulation

7 watersheds > 1,000 sq. mi.
Current conditions scenario

1984-2005 meteorology, 2000 land cover; 2001-05 withdrawals (CBP, but spatially disaggregated); current state impoundments databases (16 large impoundments simulated)

Baseline

Forest $\geq 78\%$, impervious cover $\leq 0.35\%$, no withdrawals, no discharges, no impoundments
Future conditions scenarios

1) Water use by sector: domestic, agriculture (animal), agriculture (irrigation), power, industrial.
2) CBP pop. and land use change projections to 2030, withdrawal per person is constant.
3) Same as (1) except withdrawal per person increases at 1.8% annual rate.
4) Same as (1) except withdrawal per person increases at 4.0% annual rate.
5) Simulate a dry year – 2002 – but with higher temperatures.
6) Climate change: 0.4 deg. C increase in temp., no change in annual precip. amount, but increased precip. uncertainty.
7) Increased Power Production Capacity
Water use analysis informs scenarios

Example: current and future water use for high growth and climate change scenarios
1) Compute 250+ flow statistics (IHA + HIT + others) for each scenario, each location

2) Flow alteration measured as difference between Baseline and Current; Baseline and Future; Current and Future

3) Select a refined list of flow metrics
Flow Metric Selection

High variation for the highest number of stream classes
High model efficiency (observed vs simulated for medians, inter-quartile ranges)

High variation between the current and baseline scenario AND among watersheds within the current scenario

256 Flow Metrics

Responsive to alteration
Correlated, >0.9
Not correlated
Not responsive to alteration
Remove
Continue to next step
Select one from each correlated group
Are all parts of hydrograph represented?
Yes
No
Are there multiple metrics that represent the same portion?
Yes
No
Remove metrics from duplicate hydrograph areas
Continue to next step
Add metrics to fill gaps.
Add common and/or well understood metrics
16 Flow Metrics

Definition of selection criteria
River Classification (First Cut)

Natural & anthropogenic factors
• Watershed size
• % karst
• % forest
• % impervious
• Withdrawals
• Impoundments

Middle Potomac Delineated Watersheds
Relationship between Strahler Stream Order and Watershed Size
(median: ■, box: 25th-75th %ile, whiskers: 5th-95th %ile)

NEAHCUS Classification
Great Rivers (5)
Large Rivers (4)
Medium Mainstem Rivers (3b)
Medium Tributary Rivers (3a)
Small Rivers (2)
Creeks & Headwaters (1)

Watershed Size (sq mi)

Strahler Stream Order

Jul 14 webinar: Quantitative flow-ecology relationships Part 1
1) Initial hypotheses: Bio community shows influence of river continuum, bioregions, anthropogenic impacts on water quality and on flow.

2) Objective is to separate natural from anthropogenic factors, and isolate flow impacts from water quality impacts.

3) Multiple exploratory analyses to inform selection of biometrics, river types, and flow metrics.

4) Initial suite of biometrics: 52 commonly used benthic macroinvertebrate metrics

5) How subset of biometrics selected
   a) Most responsive to anthropogenic stress, habitat degradation
   b) High variability among locations
Chessie BIBI
BECK_R
EPHEMEROPTERA_TAXA_CNT_R
EPT_TAXA_ABUND_R
EPT_TAXA_COUNT_R
FBI_R
NON_INSECT_TAXA_CNT_R
PCT_PLECOPTERA_R
PCT_SCRAPER_R

PCT_SENSITIVE_R
PCT_SHREDDER_R
PCT_SWIMMER_R
PCT_TOLERANT_R
PLECOPTERA_TAXA_CNT_R
SCRAPER_TAXA_CNT_R
SENSITIVE_TAXA_COUNT_R
SW_R
TAXA_RICH_R
TOLERANT_TAXA_COUNT_R
1) “One size does not fit all”
2) Previous work indicates biometrics respond differently to watershed size, bioregion, karst, anthropogenic stress, etc.
3) Removing sites from our analysis that are strongly influenced by anthropogenic impacts allows us to quantify the natural influences on each biometrics of:
4) Watershed size (River Continuum Concept)
5) Bioregion and karst (geomorphology)
6) Classifying streams according to the sensitivities of each biometrics will
7) Minimize variability due to natural factors
8) Bring out responses to anthropogenic-related flow alteration (impoundments, withdrawals, land uses)
1) For each location and each flow metric, compute flow alteration (baseline-current or current-future)
2) Plot versus biometrics, by river type, each biometric
3) Biometric score reflects multiple influences other than flow, but decline in maximum biometric score as flow alteration increases is an indication of flow alteration effect
4) Synthesis and Interpretation
5) Results inform Decision Making process
Example flow-ecology plot

BIBI Score vs % Change Median Flow

% Change in Median Flow

4/12/2011
Example flow - ecology plot

BIBI Score vs % Change Median Flow

Change in flow limits max possible BIBI score to below this region.
Example flow - ecology plot

This change in bio health ...

... results from this change in flow
Decision making for protecting environmental flows

Oct 27 webinar: From Science to Management Applications
Nov 29-Dec 1 workshop:
Volunteers wanted to participate in a Technical Advisory workgroup

1) Review with project team the flow alteration – ecological impact relationships as they are being developed.
2) Provided additional briefing materials beyond webinars and asked to comment on them.
3) Attend a workshop in mid to late summer.

If interested, call or e-mail Carlton Haywood at 301-274-8105, chaywood@icprb.org