Potomac Basin Large River Environmental Flow Needs: Introductory webinar for expert workshop participants September 9, 2010
Welcome and webinar overview

- ~45 minutes of presentation

- Topics:
  1. Project introduction and background
  2. Project analytical approach
  3. Developing environmental flow needs
  4. Preparing for workshop
  5. Workshop logistics

- ~30 minutes of Q&A and group discussion
  - All welcome to join in
  - Q&A process to be explained

- Technical problems? Call Webex: 866-229-3239, 1
Why focus on freshwater ecosystems?
Proportion of U.S. species at risk

From “Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity,” 1998
To develop information and tools that enable the Potomac watershed jurisdictions and water managers to protect environmental flows, defined as the seasonally variable flows of water that sustain healthy river ecosystems and the goods and services that people derive from them.
TNC interest in environmental flows to protect freshwater systems and Bay

Susquehanna River

Potomac River

Environmental flow protection and restoration is a TNC conservation priority – in the Potomac, the Chesapeake Bay, nationwide and globally
Why a concern with flows in the Potomac?

• Population growth – 10% increase per decade from 2000 to 2030

• Water demand – 20-30% increase in Metro DC water use over next 30 years

• Consumptive use for industry and agriculture

• Land use change/stormwater runoff

• Climate change
Large River Environmental Flow Needs project: part of a larger Corps project
Benefits of basin-scale project

• Provides shared framework for incorporating ecological considerations into water and land use planning

• Helps support state-level water resource planning & management goals

• Offers proactive approach to identifying and managing sources of flow alteration

• Presents opportunity to move towards a more comprehensive, basin-wide approach to Potomac resource management

• Creates forum to discuss and develop shared goals for sustainable water management, outside context of water crisis

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Large River Environmental Flow Needs: project origins and research team

Project sponsored by:

- The Nature Conservancy (TNC)
- Interstate Commission on the Potomac River Basin (ICPRB)
- National Park Service (NPS)
- U.S. Army Corps of Engineers (USACE)

Background report research team:

- Jim Cummins, Claire Buchanan, Carlton Haywood, Heidi Moltz, Adam Griggs (ICPRB);
- Than Hitt and Rita Villella (USGS);
- R. Chris Jones, Richard Kraus (GMU-PERECD)
- + Inputs from The Nature Conservancy

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Flow: The master variable

Flow Regimes
Water Levels and Flows

Physical Habitat
Water Quality
Energy Supply
Biotic Interactions

Ecological Integrity

Flow Components:
Magnitude
Duration
Timing
Frequency
Rate of change
Inter-annual variability

From Poff et al. 1997
It’s not just a matter of water volume

= Better for species & ecological systems

= Bad for species & ecological systems

This is the same volume!
Developing environmental flow recommendations for the Potomac watershed

1. Determine large river environmental flow needs:
   - Use literature review, conceptual models, and expert input
   - Define *full range of hydrologic needs for species*
   - Limitations on existing data and research

2. Develop regional, quantitative flow-ecology relationships:
   - Group streams into similar types
   - Define flow alteration/ecological response relationships by group
   - Use social/policy process to set flow recommendations
   - May 2011 Expert workshop
Large River Environmental Flow Needs

Report on Potomac flow needs
Select indicator species
- diadromous and resident fish
- freshwater invertebrates
- floodplain vegetation
- estuarine communities

Define flow needs for species’ life stages
- glochidia release
- seed dispersal and germination
- fish migration, spawning

Engage experts to review hypotheses, flow statistics, & draft flow recommendations

Discuss process to move towards quantifying recommended protective hydrologic ranges

Note: In the Potomac, we are only formally pursuing steps 1 - 3
Goal: Determine environmental flow needs for segments of the mainstem Potomac and selected large tributaries

Workshop process: Use expert input to refine initial draft flow-ecology hypotheses, statistics, and recommendations from the draft report during breakout group sessions

Expected outcome: A set of flow hypotheses and measurable flow statistics for the Potomac River and major tributaries that can be refined using an adaptive management approach
Environmental flow terms

**Ecological Indicators** – species sensitive to flow and grouped by taxa, life history strategies, and flow needs

**Environmental Flow Components** – types of flow events that represent the full spectrum of river flows and are required for ecological function: small and large floods, high flow pulses, mid-range flows, low flows, and drought flows

**Environmental Flow Needs** – the quality, quantity and timing of water flows required to maintain the components, functions, processes and resilience of aquatic ecosystems
Defining environmental flow needs

**Flow hypothesis** – a testable explanation for a suspected or observed relationship between river flow and the needs and tolerances of species and communities

**Flow statistic** – measurement of the magnitude, duration, frequency, timing, or rate of change of environmental flow components. Should be measureable, repeatable, and responsive to management.

**Flow recommendation** – recommended quantification of, or development of a range around, a flow statistic that is protective of one or more ecological indicator or function
Areas at greatest risk of hydrologic alteration

INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN

Data Sources: National Inventory of Dams; Chesapeake Bay Program 2000 Land Use and Predicted Future Land Use; Potomac Withdrawal Databases; EPA Region 3 Ecoregions; USGS AWUUDS
Literature review process

Research Team: ICPRB, USGS Aquatic Ecology Branch, George Mason University (TNC in advisory role)

- Over 480 sources relevant to environmental flow requirements for the Potomac and its ecological components
- Organized into searchable online database

Content and synthesis:

1. Ecological indicator species and key life history stages
2. Group species with similar flow-sensitivities
3. Develop flow hypotheses and conceptual diagrams
4. Choose flow statistics and make recommendations for changes in statistics that are representative of flow needs
Ecological indicator taxa

- Fishes
- Mussels
- Riparian plant communities
- Freshwater estuarine system

Chosen based on targeted life history traits, sensitivity or adaptation to flow conditions
Fishes

Functional groups and representatives:

A. Atlantic sturgeon – large bodied, flow-velocity generalists

B1. American shad – medium sized with moderate flow-velocity specialization, large home range size

B2. Smallmouth bass – medium sized with moderate flow-velocity specialization, small home range size

C. Fantail darter – small bodies, flow velocity generalists

American shad, *Alosa sapidissima*


Illustration by Ted Walke, PFBC
Mussels

Targeted life history traits:

- Brood length
- Adult size
- Fish hosts
- Substrate
- Flow velocity

Source: Texas Parks and Wildlife

Water quality and flow are essential requirements for freshwater mussels, which are good markers of the health of the ecosystem. The life cycle of the mussel:

1. Adult male freshwater mussel in the substrate of a water body releases sperm to the female.
2. The young mussels or glochidia are released into the water.
3. Glochidia attach to a fish's fins or gills.
4. Glochidia become juveniles.
5. Juveniles drop back to the substrata for the cycle to begin again.
Aquatic and riparian vegetation

- Instream – inundated all year, some seasonal exposure at edges
- Bank and bar – mean water mark to 2-yr RI flood
- True flood plain – affected by floods with 2-10 yr RI
- Flood terrace – inundated by extreme floods > 10 yr RI

© Gary P. Fleming
Freshwater estuarine system

1. Phytoplankton
2. SAV
3. Zooplankton
4. Benthic invertebrates
5. Fish
A testable explanation for a suspected or observed relationship between river flow and the needs and tolerances of the river’s species and communities

<table>
<thead>
<tr>
<th>Who</th>
<th>Species or group of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>What</td>
<td>Flow magnitude or event</td>
</tr>
<tr>
<td>When</td>
<td>Month or season</td>
</tr>
<tr>
<td>Where</td>
<td>Habitat type or unit</td>
</tr>
<tr>
<td>Why / how</td>
<td>Ecological response</td>
</tr>
</tbody>
</table>
Fish: flow hypotheses

During spring, American shad require high flows as one of several cues for upriver migrations of adults to non-tidal spawning grounds.

Loss of high spring flows may delay emigration and spawning.
During spring, American shad require high flows as one of several cues for upriver migrations of adults to non-tidal spawning grounds.

Loss of high spring flows may delay emigration and spawning.
Choosing flow statistics (“what”)

Measurements of the magnitude, duration, frequency, timing, or rate of change of environmental flow components - measureable, repeatable, and responsive to management

- Individual statistics
- Ranges of a flow duration curve
### Statistics suggested by flow hypotheses

<table>
<thead>
<tr>
<th>Flow Component</th>
<th>Flow statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>High flows</td>
<td>Bankfull (2-yr RI) and large floods (10-yr RI)</td>
</tr>
<tr>
<td></td>
<td>Magnitude of annual Q10 flow</td>
</tr>
<tr>
<td></td>
<td>Frequency of high flow events, fall and winter</td>
</tr>
<tr>
<td>Seasonal flows</td>
<td>Magnitude of monthly Q10</td>
</tr>
<tr>
<td></td>
<td>Magnitude of monthly Q50</td>
</tr>
<tr>
<td></td>
<td>Magnitude of monthly Q90</td>
</tr>
<tr>
<td>Low flows</td>
<td>Magnitude of annual Q90</td>
</tr>
<tr>
<td></td>
<td>7Q10 (7 day, 10 year) flow</td>
</tr>
<tr>
<td></td>
<td>Duration of low flow events, summer and fall</td>
</tr>
<tr>
<td></td>
<td>Low flow range (flow duration curve)</td>
</tr>
</tbody>
</table>
Flow Duration Curve

Low flow range: area under curve between Q75 and Q99
Developing flow recommendations from hypotheses (quantify “what”)

Recommended quantification of, or development of a range around, a flow statistic that is protective of one or more ecological indicator or function

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<tr>
<td>What</td>
<td>Flow statistic and recommended value or range</td>
</tr>
<tr>
<td>When</td>
<td>Month or season</td>
</tr>
<tr>
<td>Where</td>
<td>River, group of rivers, or river reach</td>
</tr>
<tr>
<td>Why/How</td>
<td>Ecological response</td>
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</table>
### Example flow recommendations: Susquehanna River

#### Table 5.1 Flow recommendations for the Susquehanna River ecosystem.

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<tr>
<th>Season</th>
<th>Flow Component</th>
<th>Flow Statistic</th>
<th>Flow Recommendations</th>
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<tr>
<td>Annual and Interannual Events</td>
<td>High Flows</td>
<td>Large flood</td>
<td>Maintain magnitude and frequency of annual Q0.05 (20-yr flood)</td>
</tr>
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<td></td>
<td>Small flood</td>
<td>Maintain magnitude and frequency of annual Q0.2 (5-yr flood)</td>
</tr>
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<td></td>
<td></td>
<td>Bankfull</td>
<td>Maintain magnitude and frequency of annual Q0.5 (Approx. 1 to 2-yr flood)</td>
</tr>
<tr>
<td>All Months</td>
<td>High flows</td>
<td>Monthly Q10</td>
<td>&lt;10% change to magnitude of monthly Q10</td>
</tr>
<tr>
<td>Seasonal flows</td>
<td>Monthly Median</td>
<td>Between 45th and 55th percentiles</td>
<td>Same for all streams</td>
</tr>
<tr>
<td></td>
<td>Monthly Range</td>
<td>≤ 20% change to area under curve between Q10 and Q75</td>
<td>Same for all streams</td>
</tr>
<tr>
<td>Low flows</td>
<td>Monthly Low Flow Range</td>
<td>No change to area under curve between Q75 and Q99</td>
<td>≤ 10% change to area under curve between Q75</td>
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Maintain baseline conditions for individual flow statistics
### Example flow recommendations: Susquehanna River

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Ranges around individual statistics
Example flow recommendations: Susquehanna River

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Area under a flow duration curve
Preparing for the workshop: review background report

In particular, focus on the following:

- Executive summary
- Summaries at the beginning of each chapter
- Flow hypotheses at the end of chapters 2 and 3
- Chapter 4 – synthesizes the flow needs of all ecological indicators and provides draft flow recommendations
- Tables 12-16
- Appendix A for explanation of some flow statistics and environmental flow components
### Tables 12-13: flow needs of ecological indicators (pp 79-88)

<table>
<thead>
<tr>
<th>Biota</th>
<th>Flow Component</th>
<th>High Flow Events</th>
<th>Mid-Range Flows</th>
<th>Low Flows</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A fish (large-bodied, long-lived, late maturation, migratory, flow-velocity generalist) e.g., American eel</td>
<td>Sep-Feb – provides one of several cues for out-migration of adult eel (silver eels) (Flow Statistics 15-# events Winter, 16-# events Spring)</td>
<td>Dec-Apr - one of several cues for upriver migrations of juvenile eel (elvers) (Flow Statistic 9-# events Fall)</td>
<td>Sept-Feb - Out-migration delayed if prolonged. (Flow Statistics 7-duration events Fall, and 8-duration events Summer)</td>
<td>• High flows trigger adult eel out-n (Smogor et al. 1995). • Migrating eels may delay migrati velocities are too low or too high (2009).</td>
<td></td>
</tr>
<tr>
<td>Group B1 fish (Alosid, medium-sized, migratory, moderate flow-velocity specialization, e.g., blueback herring, alewife, American shad)</td>
<td>Mar-Jun – provides one of several cues for upriver migrations of adults to nontidal spawning grounds Mar-Aug - high flow pulses not too numerous or too strong to cause loss of larvae and young-of-year class August-November- High flow are one emigration trigger. (Flow Statistics 13-2 yr R.I. event, 15- # events Winter, 16-# events Spring, and 18- # events Fall)</td>
<td>Mar-Jun – provide adults with access to natal spawning streams (Flow Statistics 9- Monthly Q_{90} flow, 10- Monthly Q_{50} flow, and 11- Monthly Q_{10} flow)</td>
<td>• High flows in summer limit recruit (Jenkins and Burkholder 1994) • Cues for emigration include high et al 2009).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 14: Flow statistics (pp 89)

<table>
<thead>
<tr>
<th>Flow category</th>
<th>Flow category</th>
<th>Flow Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnitude (cfs)</td>
<td>Frequency (#)</td>
</tr>
<tr>
<td>Low flows</td>
<td>1. Annual 1 day min. flow</td>
<td>Median # of low flow events</td>
</tr>
<tr>
<td>(flow &lt; Q$_{90}$)</td>
<td>2. Annual Q$_{90}$ flow</td>
<td>4. Spring (Apr - Jun)</td>
</tr>
<tr>
<td></td>
<td>3. $\gamma$Q$_{10}$ (7 day, 10 year) flow</td>
<td>5. Summer (Jul - Sep)</td>
</tr>
<tr>
<td>Mid-range flows</td>
<td>9. Monthly Q$_{90}$ flow</td>
<td>12. Annual Q$_{10}$ flow</td>
</tr>
<tr>
<td>(Q$<em>{90}$ &lt; flow &lt; Q$</em>{10}$)</td>
<td>10. Monthly Q$_{50}$ flow</td>
<td>13. 2 yr Recurrence Interval (R.I.) event (approx. bank full)</td>
</tr>
<tr>
<td></td>
<td>11. Monthly Q$_{10}$ flow</td>
<td>14. 10 yr R.I. event (Large flood)</td>
</tr>
<tr>
<td>(&gt; annual Q$_{10}$), Small Floods (2 yr R.I. and &lt; 10 yr R.I. event), and Large Floods (&gt;= 10 yr R.I. event)</td>
<td>13. 2 yr Recurrence Interval (R.I.) event (approx. bank full)</td>
<td>17. Summer (Jul - Sep)</td>
</tr>
<tr>
<td></td>
<td>14. 10 yr R.I. event (Large flood)</td>
<td>18. Fall (Oct - Dec)</td>
</tr>
</tbody>
</table>
Preparing for the workshop: questions for your consideration

- Do the flow hypotheses adequately represent the flow needs of the ecological indicators?
- Do the recommended flow statistics adequately represent the flow needs for each hypothesis?
- Are current conditions appropriate to use as a baseline for flow recommendations?
- Please come prepared to discuss these questions and provide expert opinion to determine environmental flow needs and monitoring priorities.
Specific workshop tasks

- Review flow-ecology hypotheses and draft flow recommendations from summary report
- Determine adequacy of current conditions to meet ecological needs
- Review proposed environmental flow statistics that reflect flow needs
- Identify best approaches to characterizing change
- Identify and prioritize longer-term research and monitoring
- Discuss potential applications and approaches to protecting natural flows in the Potomac mainstem and selected large tributaries
Workshop logistics

• Meetings at National Conservation Training Center (NCTC)
• All registrants to date will have lodging at NCTC
• Starts 10 am on Day 1, Wed. Sept. 22 – please arrive by 9:30am
• Ends 4pm on Day 2, Thurs. Sept. 23

NCTC is located along the Potomac River in Shepherdstown, WV

Note: registration closes 9/13
Lodging space at NCTC running out
Interactive Workshop:

- Plenary sessions
- Breakout sessions
- Wed. evening dinner and after-dinner reception at NCTC
- Thurs. lunchtime speaker: Brian Richter, TNC’s Director of Freshwater Conservation
- Revised agenda, registration confirmation to come
Reminder: Important note to government employees

Must send TNC letter of permission for TNC to cover your workshop costs by 9/13/10

Contact Stephanie Flack if you have any questions
Discussion / Question and Answer Session

Process

- All phones muted, except recognized speaker
- Raise “hand” to make comment or ask question
- When recognized, speaker’s phone un-muted
- Lower “hand” when finished speaking
- We will also answer any questions raised using the “chat” function during the presentation
For more information on workshop or background report

Project leads from TNC and ICPRB:

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Julie Zimmerman, The Nature Conservancy, jzimmerman@tnc.org, 301-897-8570 x220

Jim Cummins, Interstate Commission on the Potomac River Basin, jcummins@icprb.org, 301-274-8106

Carlton Haywood, Interstate Commission on the Potomac River Basin, chaywood@icprb.org, 301-274-8105

For more information, visit potomacriver.org/sustainableflows