Middle Potomac River Watershed Assessment: Findings and Lessons Learned

Eighth of a multi-part webinar series
June 21, 2012

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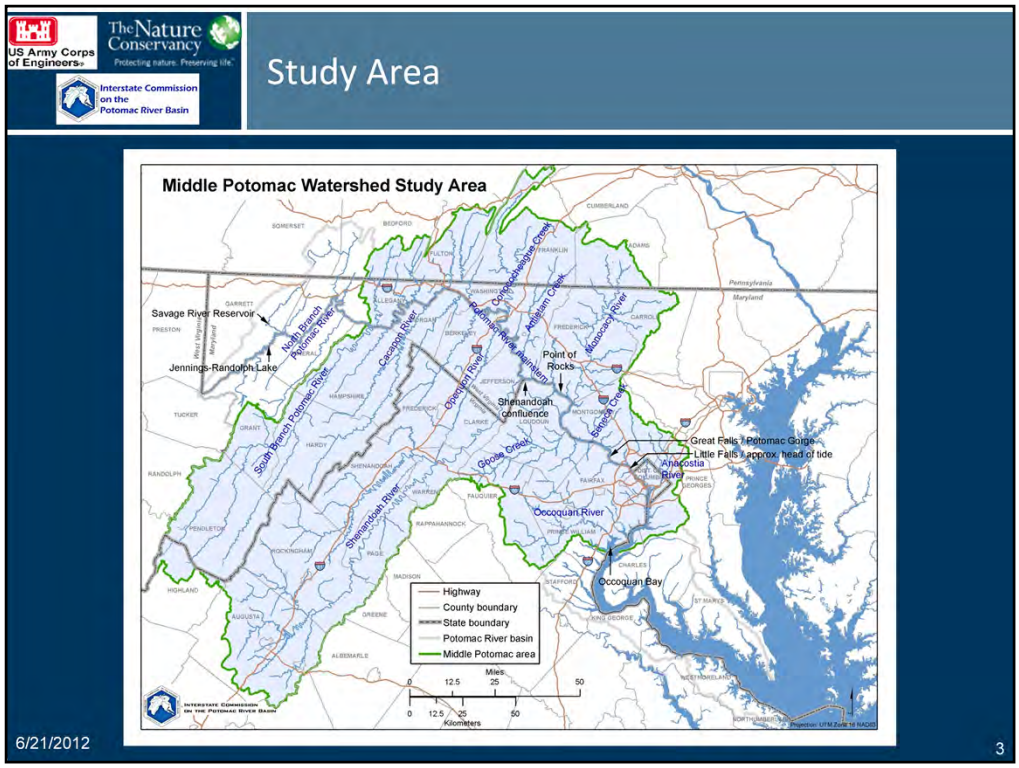
Middle Potomac River Watershed Assessment: Findings and Lessons Learned

Speakers

Andrew Roach, U.S. Army Corps of Engineers, Baltimore District

Carlton Haywood, Interstate Commission on the Potomac River Basin

Project website: www.potomacriver.org/2012/projects/middle-pot-assess



A map of the study area.

Note that it officially does not include the North Branch.

However, we it was necessary to include the North Branch in the watershed model in order to get downstream flows correct

And, we did model some small watersheds in the North Branch where biological data were available.

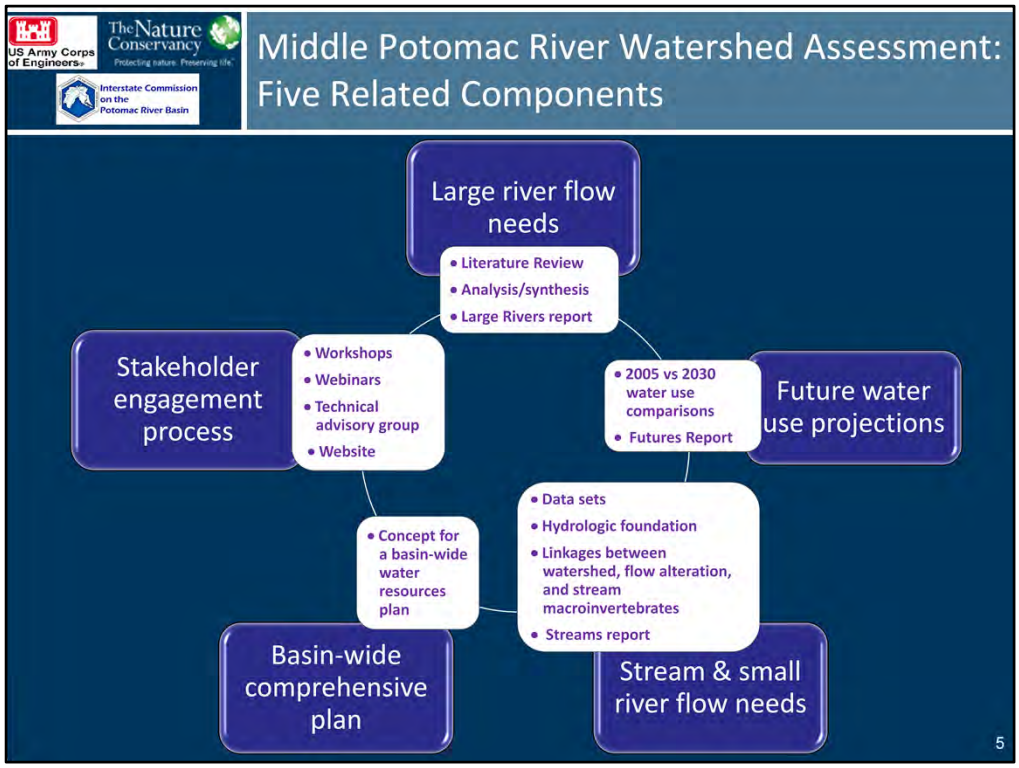
In addition to major tributary streams, significant points on the Potomac river are indicated (Shenandoah confluence, Point of Rocks, Great Falls, Little Falls, and Occoquan Bay) which delineate mainstem reaches discussed in the Large River Flows portion of this study.

Study Objectives

1) Estimate current and future human water withdrawals and their impacts on stream & river flows

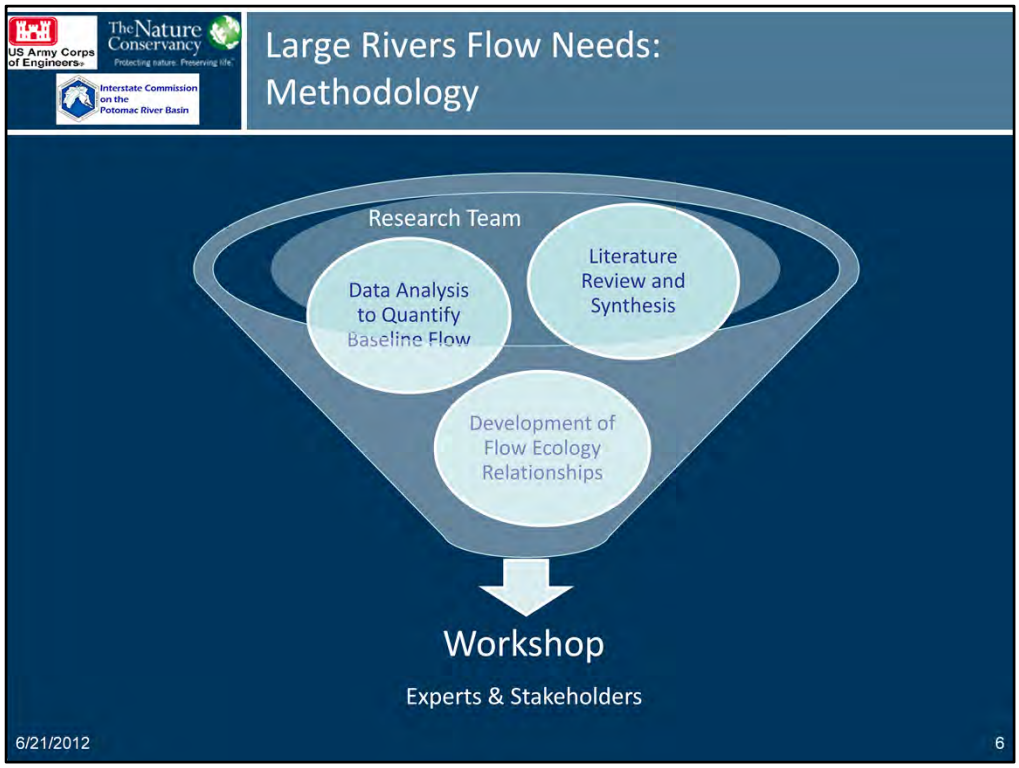
2) Characterize flows needed to support healthy stream biotic communities

3) Provide baseline information and analyses to support water use decision making



This graphic illustrates that the Middle Potomac River Watershed Assessment comprised five distinct components and lists the products from each.

I will address each of these in the following slides, identifying the major findings and lessons learned.



Methodology

The objective of the large river project was to identify the hydrologic needs of flow-dependent species and communities in the Potomac mainstem, two large tributaries and the tidal fresh estuary. We used a modification of the 6-step "Ecologically Sustainable Water Management" approach described by Richter et al. (2006). The approach relied heavily on a review of the literature, the collective knowledge of the research team, and the expert judgment of a diverse group of participants that attended a two day workshop.

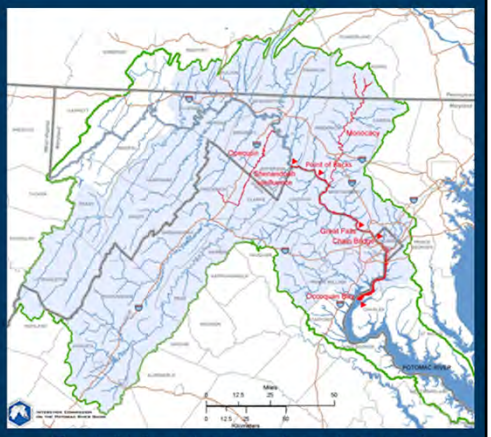
Large River Flow Needs: Findings

1) The Potomac river is, except for low flows, an unmanaged river and flows are naturally highly variable

2) Existing data do not show that flow alteration to-date has adversely affected key species; other factors have greater impact (e.g. pollution, sedimentation)

3) Recommend no change to minimum flow-by at Little Falls

4) For the entire range of flows, the current flow characteristics should be maintained as a precautionary principle



The study's large river segments are shown in red.

Final report: www.potomacriver.org/2012/publicationspdf/ICPRB10-3.pdf

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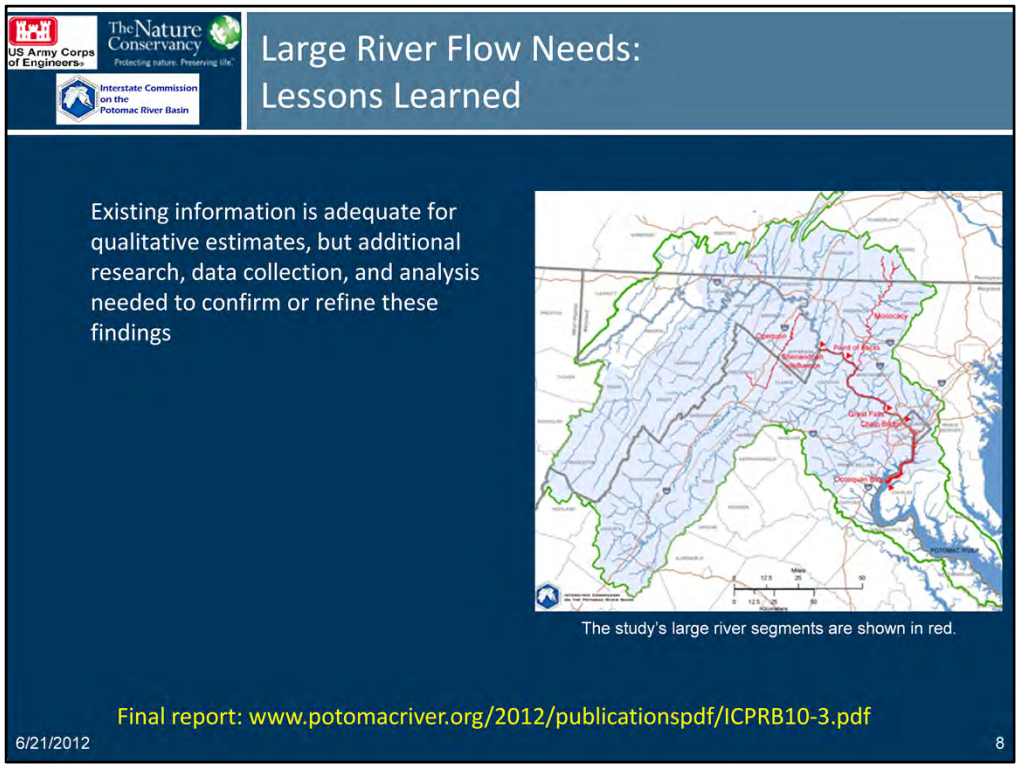
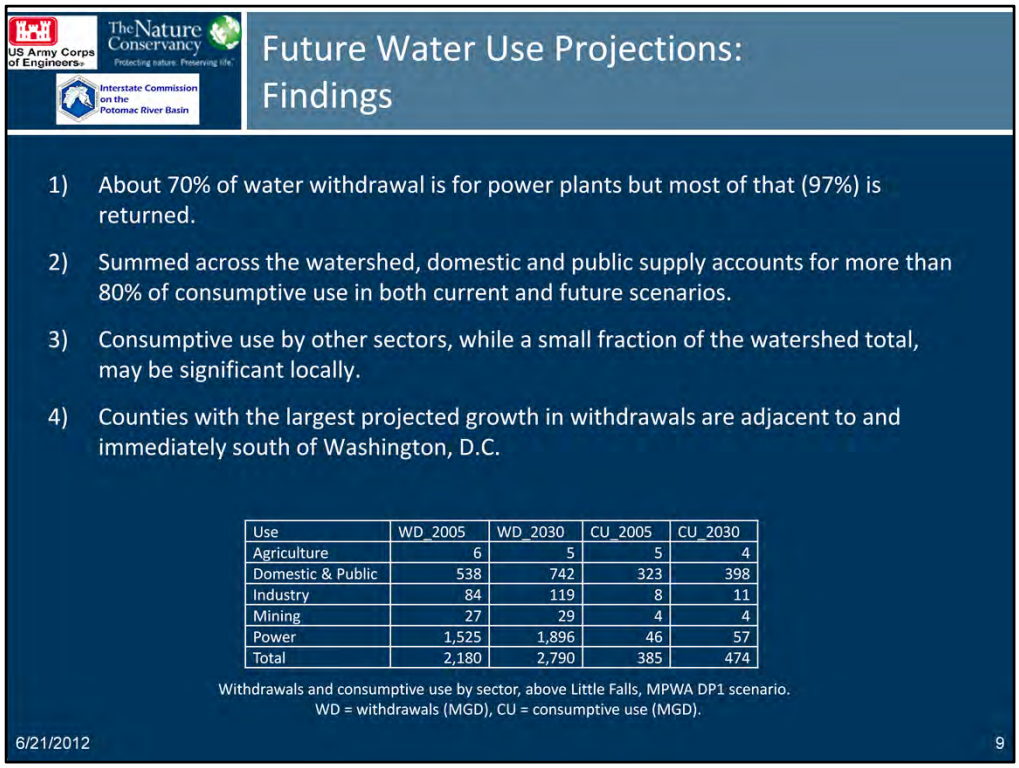
Findings



Lessons Learned

Our report identifies information gaps and recommends additional data collection to fill those gaps.

An interagency workgroup, sponsored by MD DNR, has met already to begin scoping out requirements for additional data collection.


US Army Corps of Engineers
The Nature Conservancy
Protecting nature. Preserving life.
Interstate Commission on the Potomac River Basin
Future Water Use Projections:
Findings
1) About 70% of water withdrawal is for power plants but most of that (97%) is returned.
2) Summed across the watershed, domestic and public supply accounts for more than 80% of consumptive use in both current and future scenarios.
3) Consumptive use by other sectors, while a small fraction of the watershed total, may be significant locally.
4) Counties with the largest projected growth in withdrawals are adjacent to and immediately south of Washington, D.C.
Use | WD_2005 | WD_2030 | CU_2005 | CU_2030
Agriculture | 6 | 5 | 5 | 4
Domestic & Public | 538 | 742 | 323 | 398
Industry | 84 | 119 | 8 | 11
Mining | 27 | 29 | 4 | 4
Power | 1,525 | 1,896 | 46 | 57
Total | 2,180 | 2,790 | 385 | 474
Withdrawals and consumptive use by sector, above Little Falls, MPWA DP1 scenario.
WD = withdrawals (MGD), CU = consumptive use (MGD).
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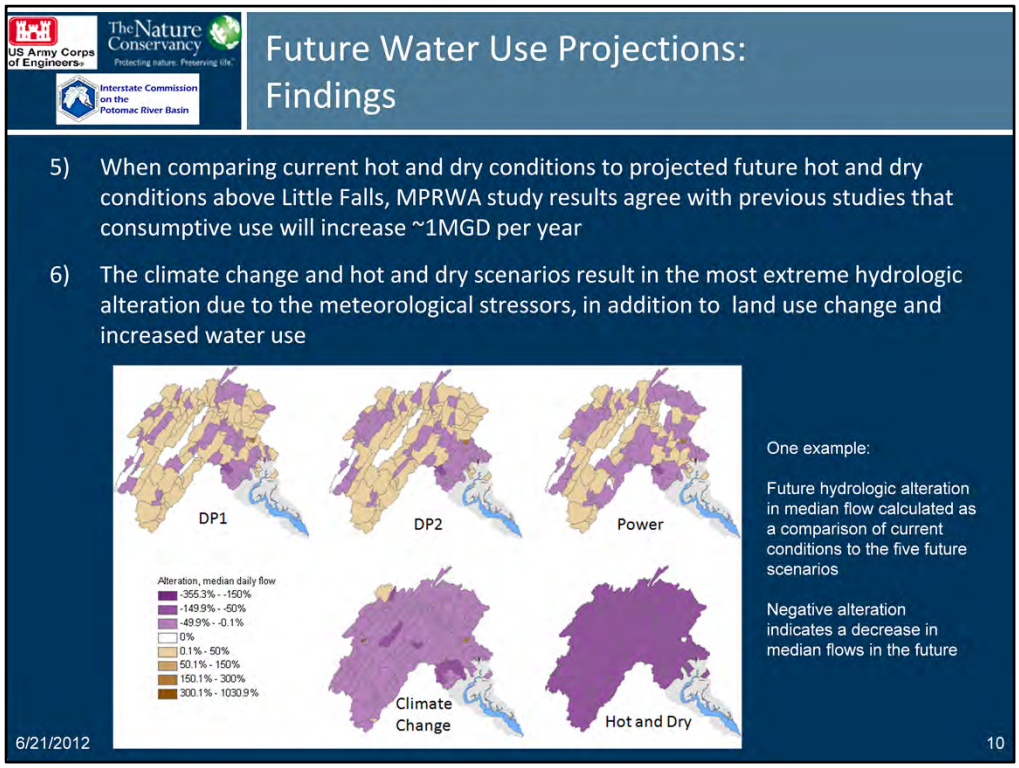
Findings



This graphic illustrates the effect on median flow of different assumptions for five alternative future scenarios.

DP1 – Changes in land uses and population increases

DP2 – Changes in land uses, population increases, and increase in per capita consumption

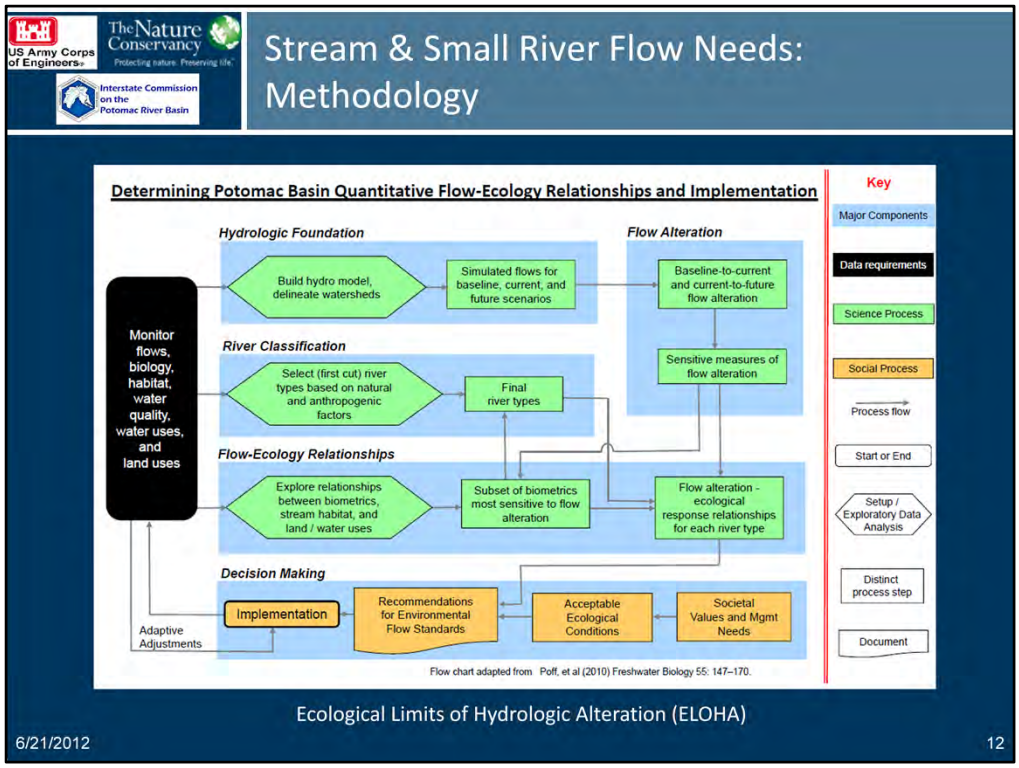
Power – Increases in power production, addition of one new power plant, and conversion of power plants to closed cycle cooling

Climate change - increasing temperature, no change in precip.

Hot & Dry - extreme drought

Future Water Use Projections: Lessons Learned

1) Projecting future conditions is strongly affected by the large uncertainties associated with assumptions..
   - Bound the range of possible futures
   - Understand methodological differences between studies
   - Evaluate model performance by retrospective analysis

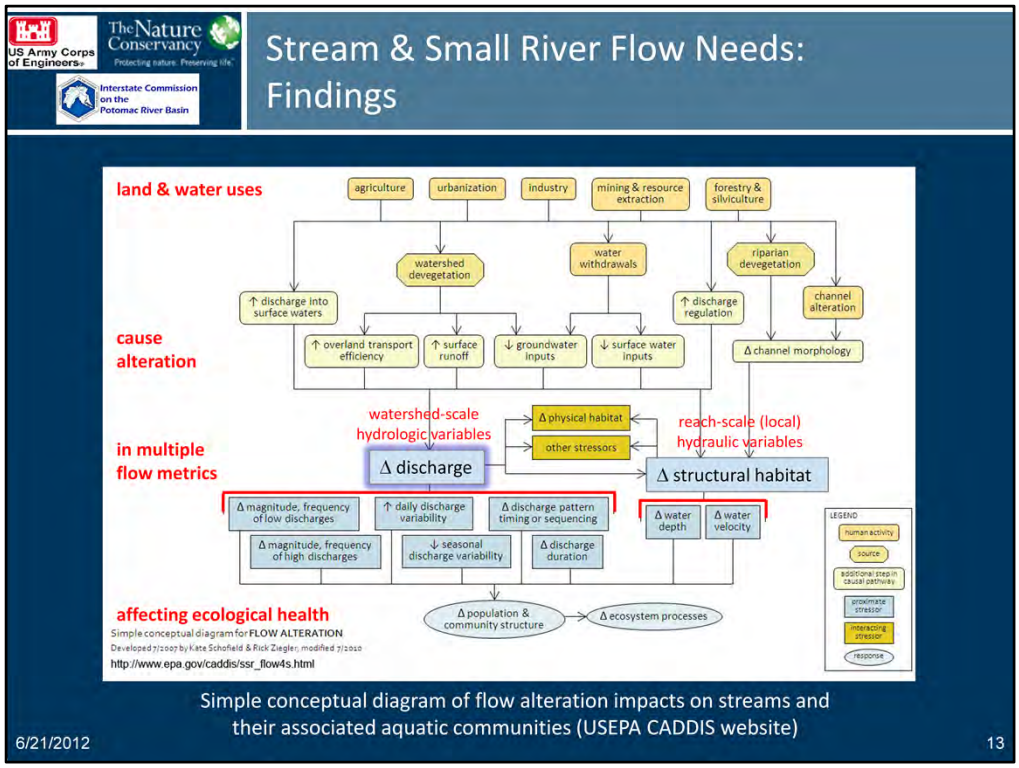


Our stream and small river flow needs task used the Ecological Limits of Hydrologic Alteration, or ELOHA, methodological approach described by Poff et al.

This graphic illustrates the process steps involved

- Building a model to simulate flows
- Evaluating natural and anthropogenic factors affecting flows
- Calculating flow alteration between baseline, current, and future scenarios
- Evaluating natural and anthropogenic factors affecting biota (as expressed in selected biometrics)
- Selecting biometrics most sensitive to flow alteration
- Developing flow alteration – ecological response relationships

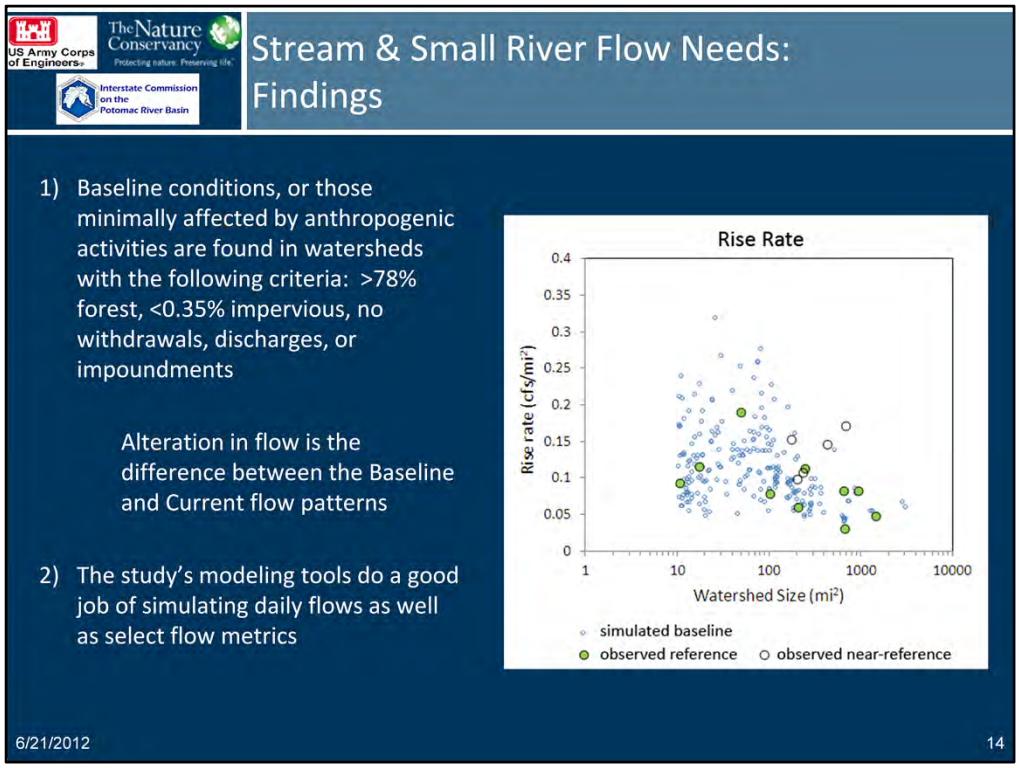
This project developed these relationships but did not take up the social process steps of translating those relationships into environmental flow standards.



HOW DO I SEGUE FROM PREVIOUS SLIDE TO THIS ONE?

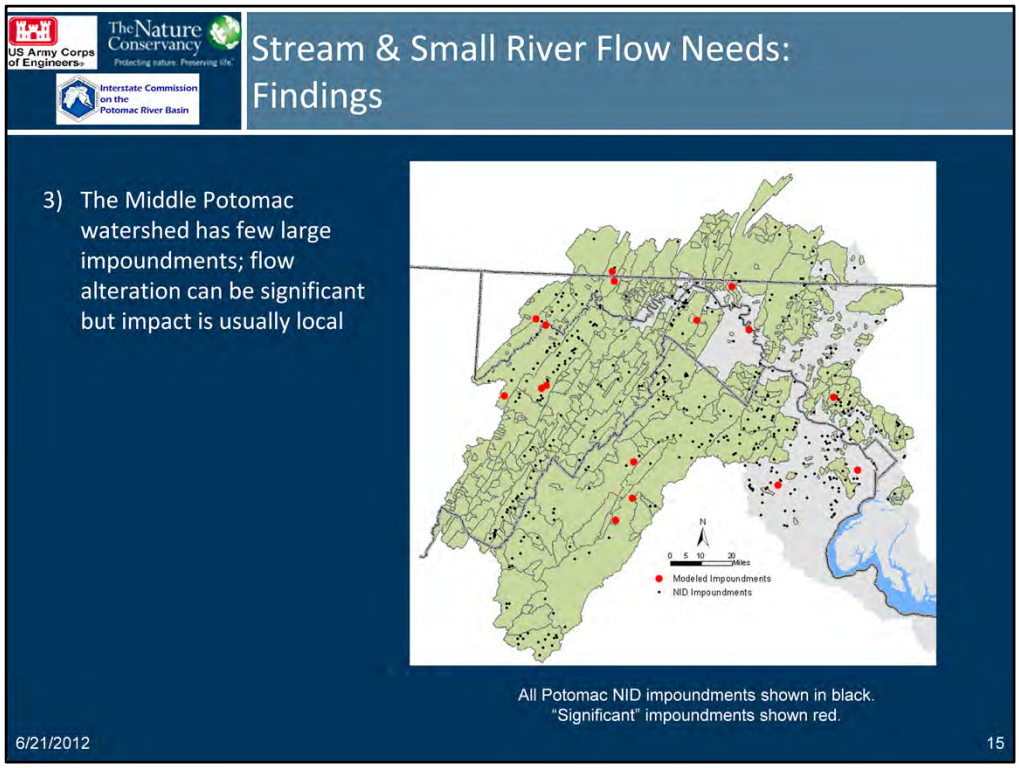
Many studies have documented the flow impacts of land and water uses in the watershed and the impacts of flow alteration on stream communities. This is a simplified diagram summarizing all the known causes and consequences to stream communities of flow alteration. It was developed by the US EPA and is available – with references to supporting literature – on their CADDIS website (URL is in lower left corner). There are many anthropogenic activities that can cause flow alteration. Some work in concert to alter flow; others have opposing effects such as withdrawals and discharges. Flow alteration is the net impact of all watershed activities.

Flow alteration can be measured on a watershed basis by examining metrics representing discharge characteristics (on the left side). The units of these metrics are volume moving downstream per unit time. Discharge is measured at USGS flow gages located throughout the watershed. The daily average discharge values are readily available on the USGS website and they can be modeled with some accuracy. In the Middle Potomac study, we used flow metrics calculated from daily discharge. Flow alteration can also be measured on a reach-basis using metrics that relate directly to the local habitat conditions, such as water depth and velocity. These measures vary by reach and are not commonly measured, so they are difficult to model. Velocity is the rate of travel downstream and its units are is distance per unit time. The two types of metrics are "different sides of the same coin."



- In the example shown, simulated and observed values for the flow metric "rise rate" are compared and show good agreement for watersheds of varying size.

- To remove the confounding effects of all anthropogenic activities, the simulated rise rates from the model's baseline scenario (small blue open circles) are compared to observed rise rates in undisturbed or "reference" watersheds (large green circles).
- Reference watersheds meet the criteria used to model the baseline scenario.
- (Also shown are some watersheds that nearly meet these criteria – large open circles.)

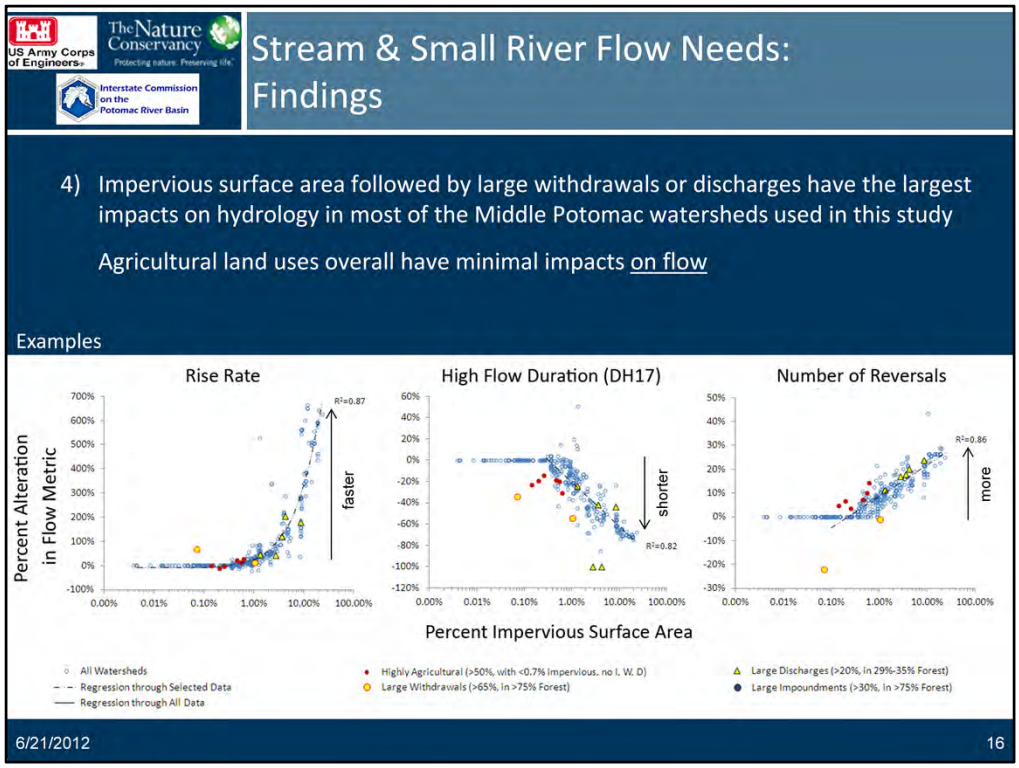


One objective of the project was to evaluate the impact of impoundments on flow alteration and biological status.

In the Potomac basin, however, there are few large impoundments and nearly all are "run of river".

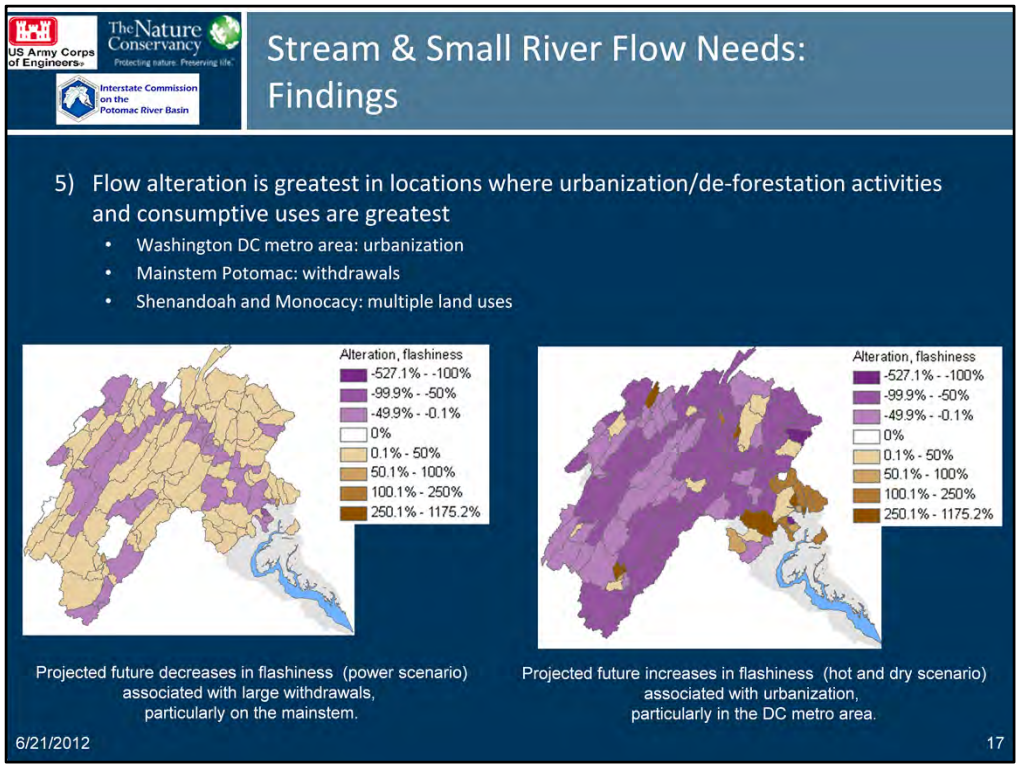
There were too few large impoundments with associated biological data to make definitive statements about their impact on biota

Significant impoundments are those with storage >= 10% annual discharge or are for hydroelectric purpose



- Increasing impervious surface area was found to have the greatest impact on flows,
- With large withdrawals and large discharges being the next most important factors.
- The data do not show much impact from increasing agricultural land use.

- These graphics show the impact of increasing impervious surface area on three flow metrics: rise rate, high flow duration, and number of reversals.
- Note that there appears to be a distinct breakpoint at about 1% impervious surface area.



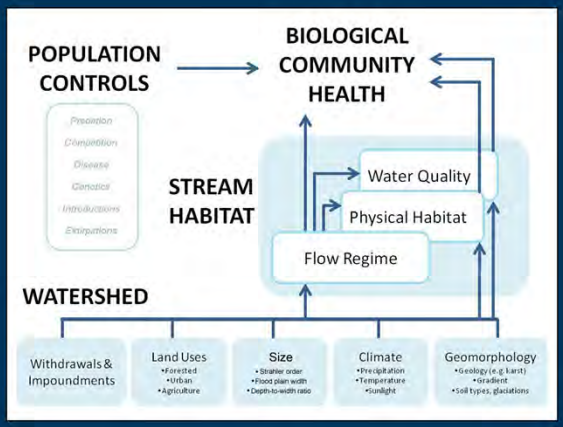
The figure on the left shows where flashiness is most impacted by increasing withdrawals in a future scenario.

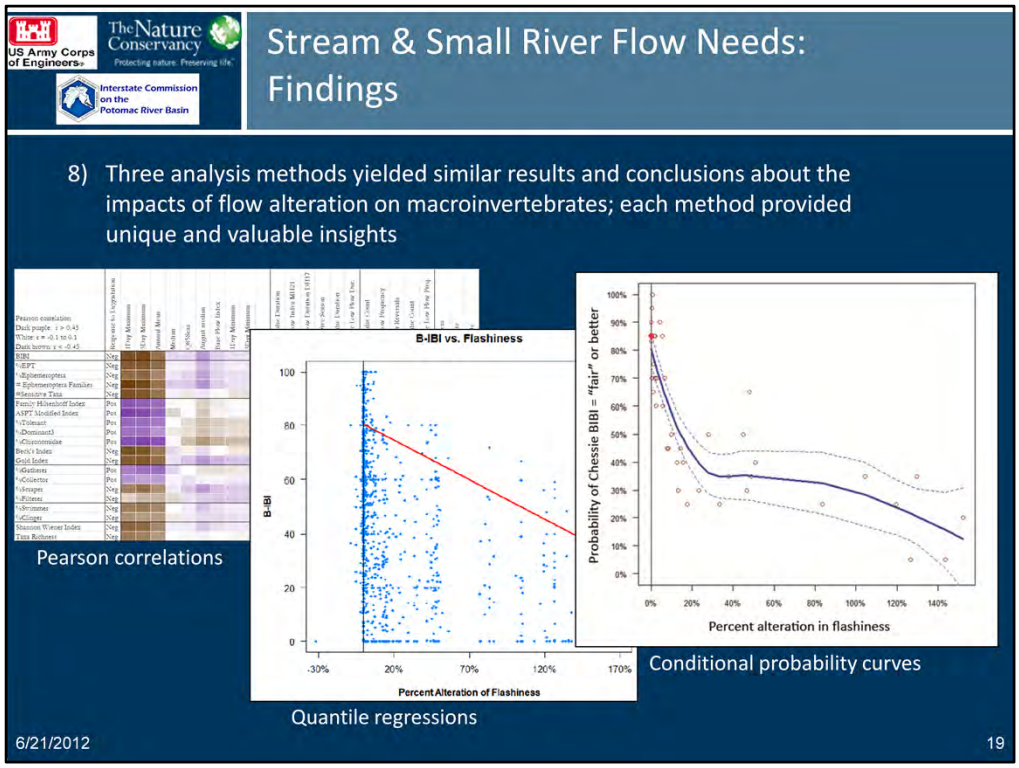
The figure on the right shows flashiness decreasing throughout most of the basin for the extreme drought scenario, but increases in flashiness are found in urban areas regardless of meteorological conditions.

Stream & Small River Flow Needs: Findings

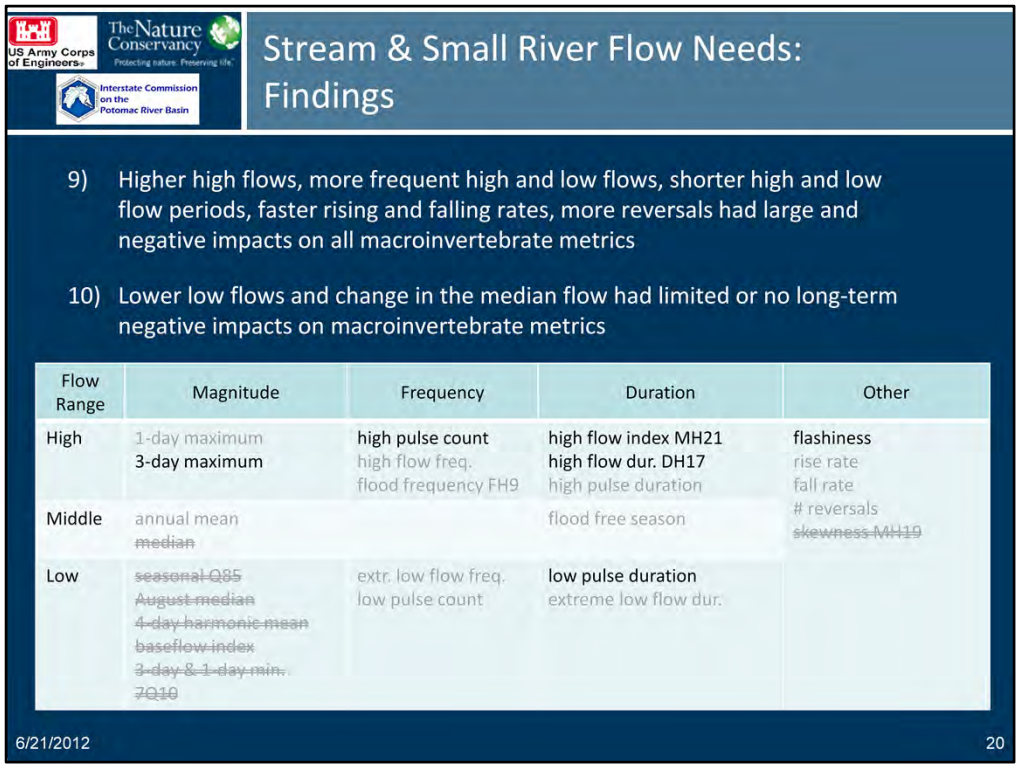
6) Macrobenthic invertebrate health is dependent on a number of factors

7) Flow regime is only one of these factors





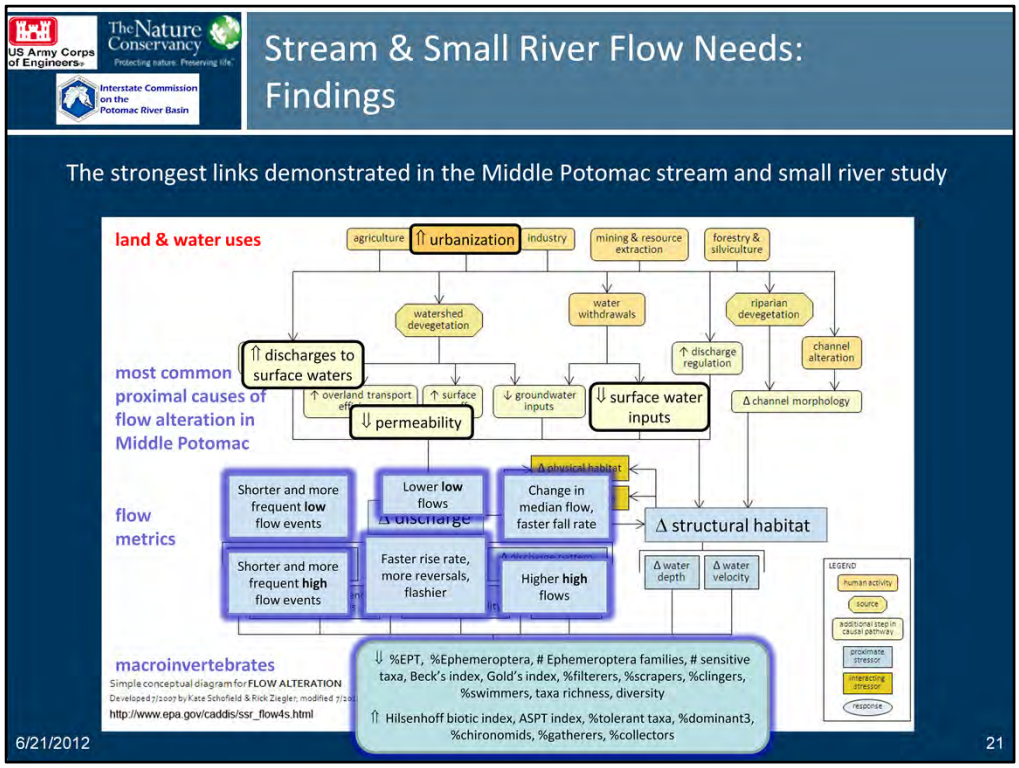
1) Correlations identified those biometrics with values that are most associated with alteration in specific flow metrics
2) Quantile regressions showed, for certain flow metrics and biometrics, that, as alteration in flow increased, there is a decline in the best achievable biometric value.
3) Conditional probability plots showed the probability of any location having a fair or better biological status for a given amount of flow alteration
4) Using these methods we identified a small set of benthic macroinvertebrate biometrics and flow metrics that most clearly showed a relationship between flow alteration and degraded biological condition.



These results pertain to flows experienced in water years 1984 to 2005, which was the Middle Potomac Watershed Assessment study period.

Table lists all the flow metrics that were analyzed at some point in the MPRWA stream project

- Gray text with strikeout – macroinvertebrate metrics showed weak or no response to alteration in these flow metrics
- Gray text with no strikeout – macroinvertebrate metrics responded to alteration in these flow metrics
- Black text – macroinvertebrate metrics responded to alteration in these flow metrics and these metrics were eventually selected to represent FA-E relationships



Using the CADDIS framework shown previously, we can summarize the results from the Stream and Small River project as follows:

• in the Middle Potomac, factors relating to urbanization, and specifically incr. impervious surface (decr. permeability) followed by surface withdrawals and discharges, appear to be the most common proximal causes of flow alteration in the watershed

• flow alteration is most often expressed in the Middle Potomac watershed as

1) higher high flow events (greater magnitude)

2) shorter and more frequent low flow events

3) shorter and more frequent high flow events

4) greater flashiness, which consists of faster rise rates and more reversals

5) lower magnitude low flows

6) a few watersheds had median flows higher or lower than baseline flows (usually related to impoundments, discharges, and/or withdrawals)

• degradation in all of the stream macroinvertebrate metrics was associated with alteration in flow metrics highlighted in dark blue - high magnitude flow, the duration and frequency of high flow events and of low flow events, and faster rise rates and more reversals (flashiness)

• lower low flows, faster fall rates, and changes in median flow (highlighted in yellow) do not appear to impact any of the macroinvertebrate metrics—at least as presently experienced in the Middle Potomac

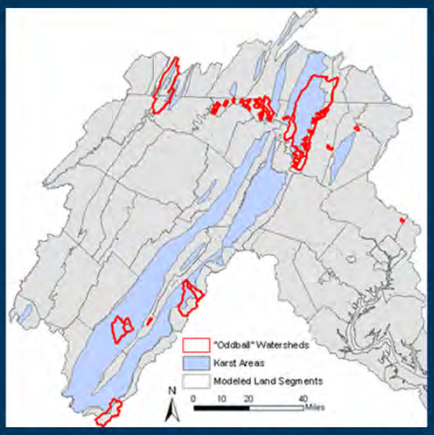
• **Reminder**: degradation in macroinvertebrate metrics is a decrease in desirable aspects of the community (such as %EPT) or an increase in undesirable aspects of the community (such as %tolerant taxa). In this study, the actual values of each macroinvertebrate metrics were converted to scores on a common scale in order to minimize natural variability in the communities due to ecoregion, stream size, season, and karst geology.

Stream & Small River Flow Needs: Lessons Learned

1) Limitations of this model (as with all models) and data should be considered when interpreting results

   - Withdrawal and discharge databases are not linked
   - Model does not simulate groundwater withdrawals
   - Paucity of flow gages on small streams and in karst watersheds limits ability to evaluate model performance in these watersheds

2) Interstate monitoring data for fish, mussels, and plants is limited in Middle Potomac so potential flow alteration impacts on these taxonomic groups are not addressed in this study



Location of watersheds with outlier flow metrics compared to areas of karst geology.

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This graphic shows watersheds with outlier flow metric values. These watersheds

a) Tend to coincide with karst geology

b) There is no observed flow data for verification

Without observed data we can't evaluate model predictions.

Basin-wide Comprehensive Plan: Findings

1) A comprehensive plan can pro-actively identify and address interstate water resources issues

2) Benefits include:
   - integration of existing data and research at the basin scale
   - enhancing interstate collaboration
   - enhancing jurisdiction planning by taking a basin-wide perspective
   - increasing cost efficiency through collaboration

3) Design and implementation of the plan requires active participation and decision-making by all stakeholders and levels of government

4) Many basin stakeholders have expressed interest

Stakeholder Engagement: Findings and Lessons Learned

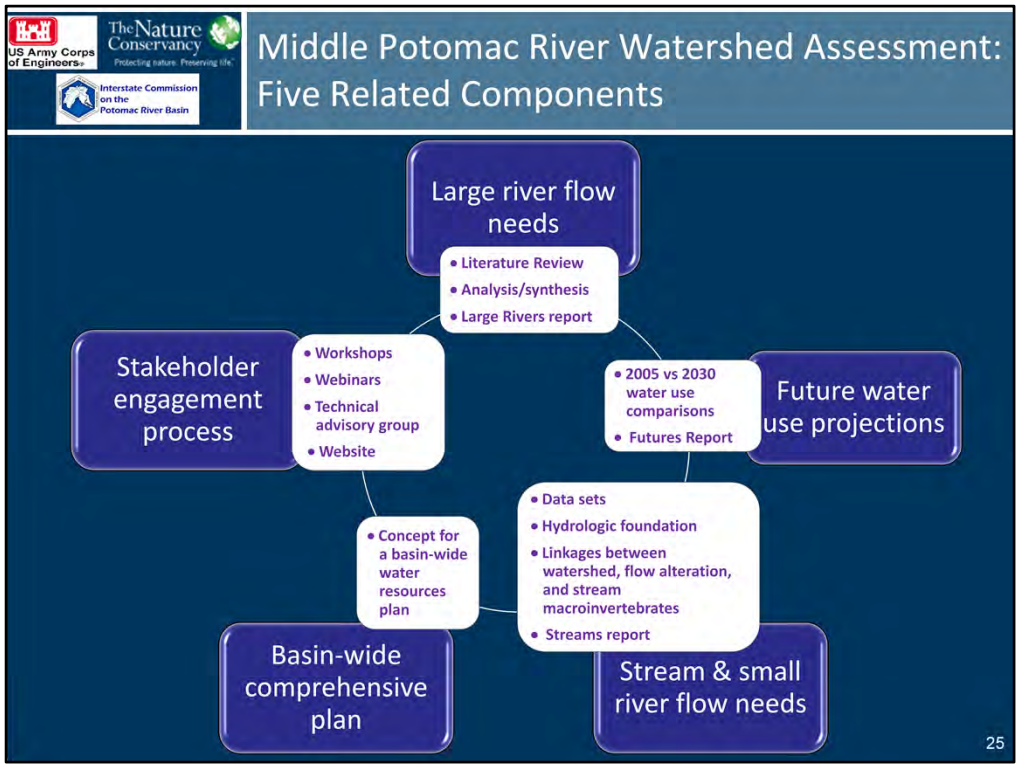
Workshops, webinars, technical advisory group, website

Findings

1) Feedback was very constructive and helpful
2) Stakeholder engagement allows for better fit of results with state processes in future

Lesson learned

1) Multiple paths of communication are important to success
2) Consensus is not required but having everyone at the table is absolutely necessary
3) Sharing findings as they evolve is important



The five related components of the Middle Potomac Watershed Assessment suggest several overarching recommendations for research, data collection and modeling.

Research Recommendations

Enhanced understanding of:

1) Flow alteration in Coastal Plain watersheds, small watersheds (<10mi^2), and karst watersheds

2) The confounding influences of non-flow factors impacting biological communities

3) Effectiveness of management actions to ameliorate the negative impacts of low and high flow conditions (BMPs)

Data Collection Recommendations

1) Additional vegetation, mussel, fish, macroinvertebrate, amphibian, and reptile monitoring, especially in large river systems

2) Continued, long-term operation of the Potomac basin stream gage network

3) Additional streamflow monitoring on small watersheds, karst watersheds, and Coastal Plain watersheds

Modeling Recommendations

1) Inclusion of groundwater withdrawals

2) Higher resolution of withdrawal and discharge locations

3) Higher resolution meteorological inputs for simulation of flows is small watersheds

4) Evaluation of spatially explicit land use practices

Next Steps

1) Continue to work with the technical workgroup, under the Maryland Department of Natural Resources, to develop a hydroecological monitoring plan and priority research needs list for the mainstem Potomac River

2) Jurisdiction-specific consideration as to how the land and water uses, flow alteration, and ecological status can be used to inform watershed management decisions

3) Use study results to inform further development of the Potomac Basin Comprehensive Water Resources Plan and individual state plans

Next Steps

4) Use FA-E curves to foster discussion and build consensus on acceptable levels of biological degradation resulting from changes in the flow regime

5) Additional research, data collection, or analysis

6) Use of project data products to support other planning and management needs of the basin jurisdictions

Project Wrap-Up

- US Army Corps of Engineers ongoing review of report to be completed in November 2012
- Workshop participants and TAG also reviewing report
- Data products and appendices available now
- State briefings in fall 2012
- Anticipated final release of final document to the public in December 2012

Questions? Comments?

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