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Middle Potomac Watershed Assessment
From Science to Management Applications
Sixth of a seven-part webinar series
October 27, 2011
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Middle Potomac Watershed Assessment
From Science to Management Applications

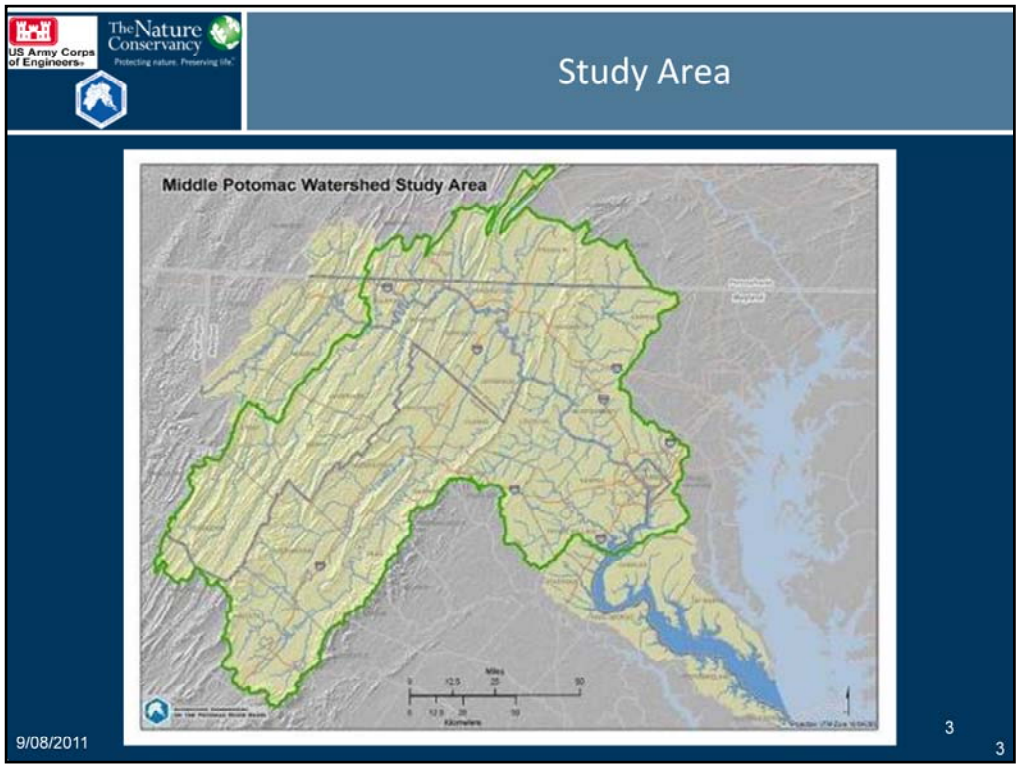
Speakers

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

Carlton Haywood, Interstate Commission on the Potomac River Basin

Colin Apse, Freshwater Conservation Advisor, The Nature Conservancy

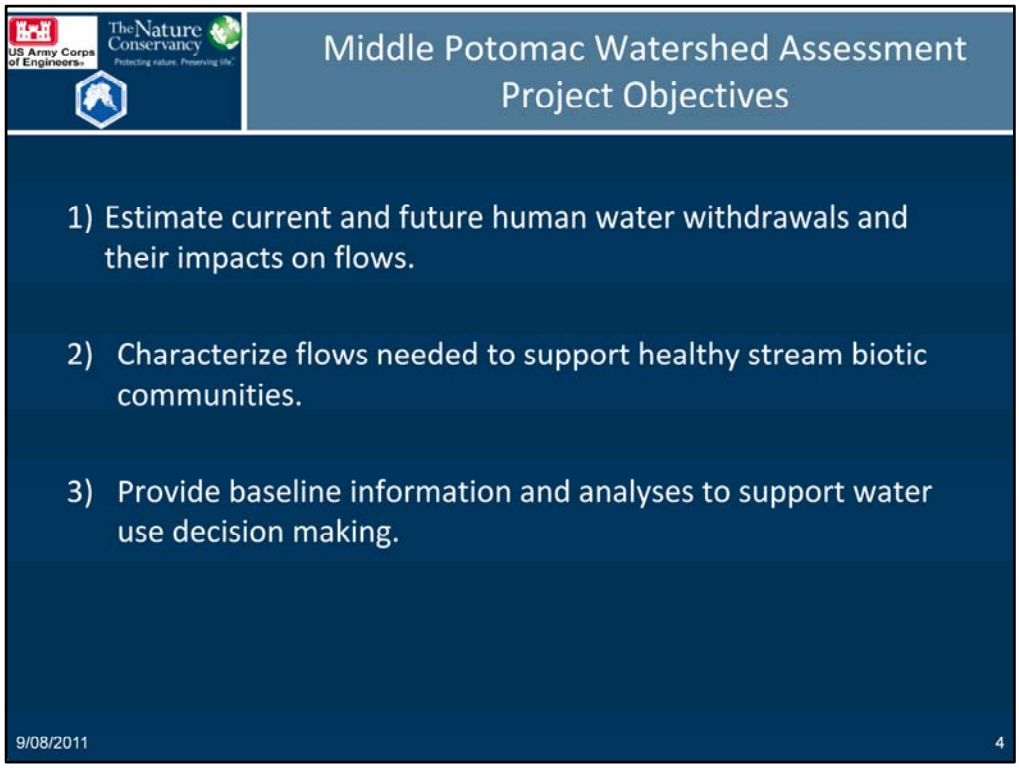
Project website: http://potomacriver.org/sustainableflows



Study area comprises approximately 11,500 sq. miles of the 14,670 sq. miles of the entire Potomac watershed.

Parts of four states, MD, PA, VA, WV and all of the District of Columbia.

Note that the official study area does not include the North Branch. Recognizing, however, that flow from the North Branch watershed is an essential driver for flows in the Potomac mainstem, this study includes the North Branch for some analytical purposes.



Project Purpose

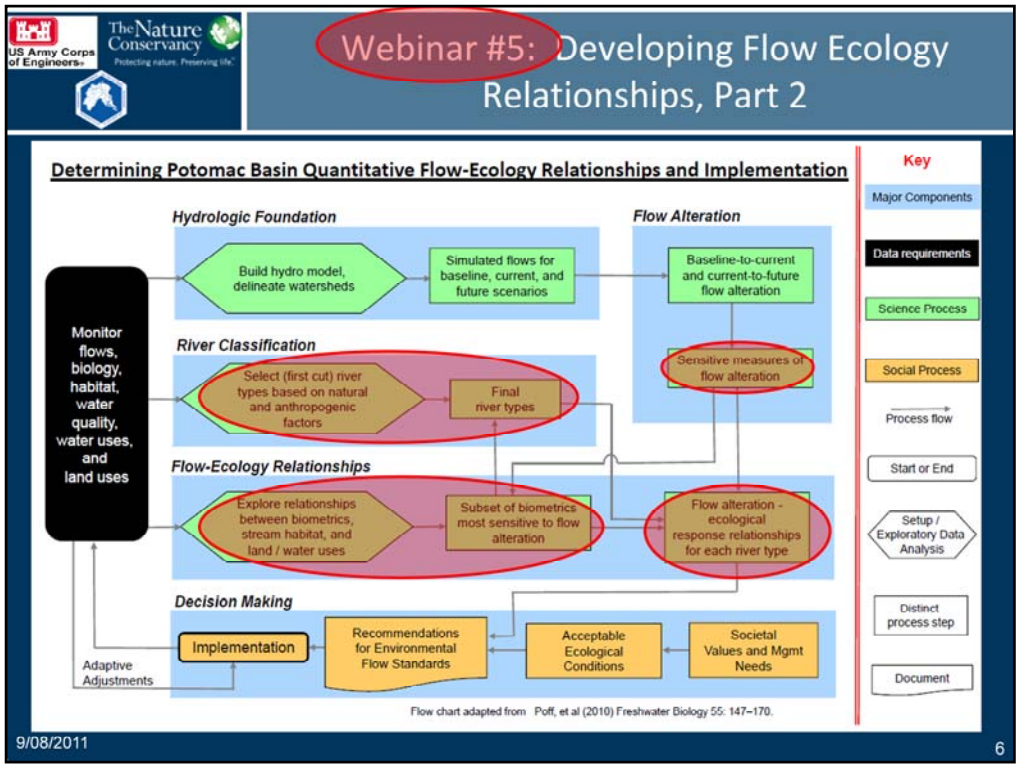
To develop information and tools that enable the Potomac watershed jurisdictions to protect **environmental flows**,

which are

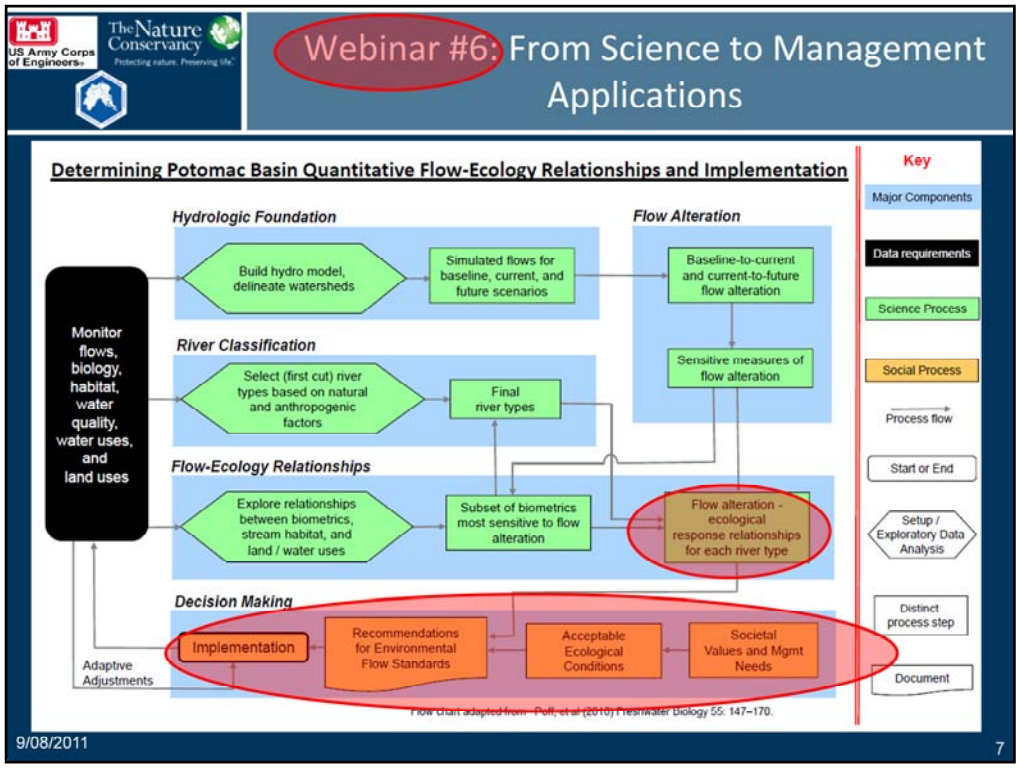
the stream flow characteristics that sustain healthy river ecosystems and the goods and services that people derive from them.

Note: There have been some changes in the schedule and subject matter of webinars and the workshop

This will be explained at the end of this webinar.



In the last webinar I showed how flow alteration – ecology plots are constructed, provide some examples, and discuss next steps for our analysis.



In this webinar I will show you a few examples of flow alteration – ecological response relationships, still evolving, and then we're going to introduce the subject of management applications with Colin Apse describing how environmental flows have been used elsewhere.

Recall the project objective to "Characterize flows needed to support healthy stream biotic communities. "

To that end we have

-Assembled flow, biology, and watershed characteristics datasets

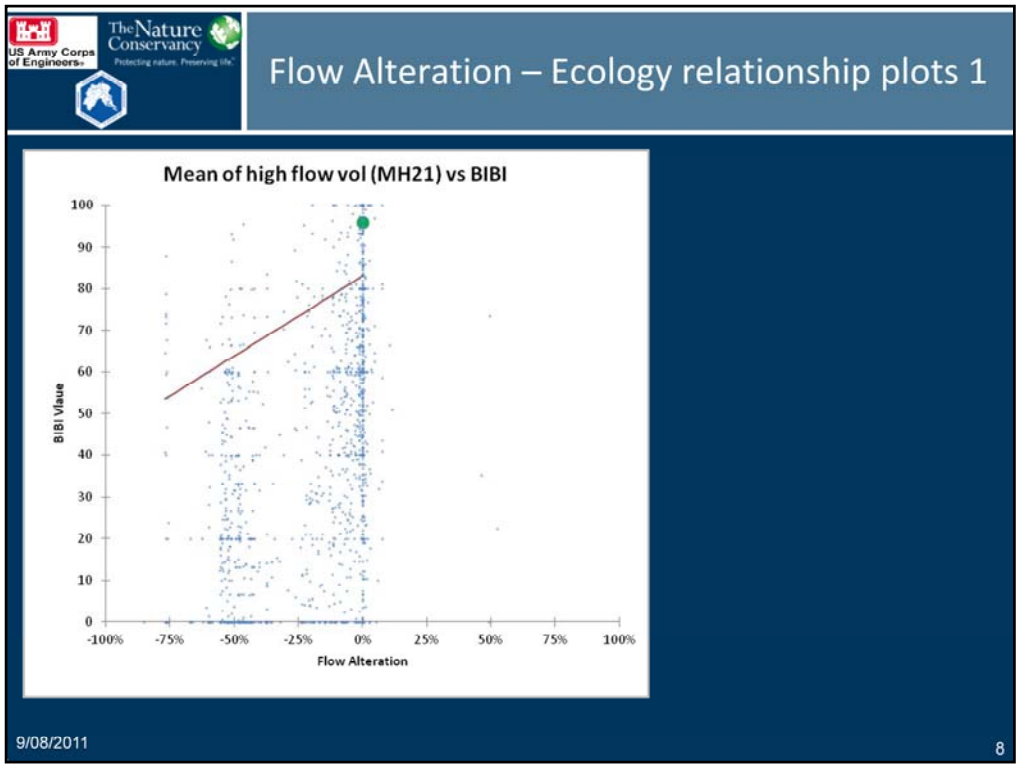
-Built a hydrologic model to simulate flows for current and baseline conditions scenarios

-Computed flow statistics for current and baseline scenarios

-Computed biology statistics, or biometrics, for our macroinvertebrate samples

-Examined the influence of watershed characteristics on flow and biology

-And are examining ways to show flow alteration – ecological response relationships



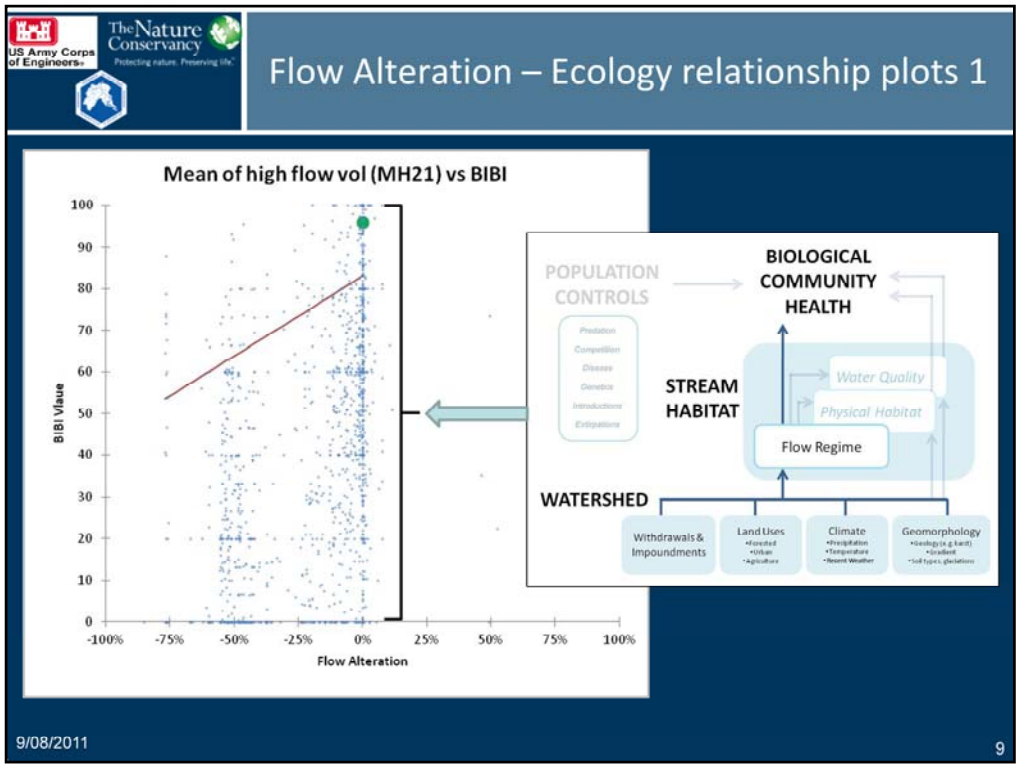
Here is an example relationship where the X-axis is Alteration in Mean High Flow Volume

[(Current – Baseline) / Baseline]

The Y-axis is the Benthic Index of Biotic Indicators (BIBI), a measure of community health,

Blue dots are BIBI results for samples collected 2000 – 2008

The straight line is a linear 90% quantile regression



Distribution of biometric values from 0 to 100 illustrate the ecological response to many influences.

Here is an example relationship where the X-axis is Alteration in Mean High Flow Volume

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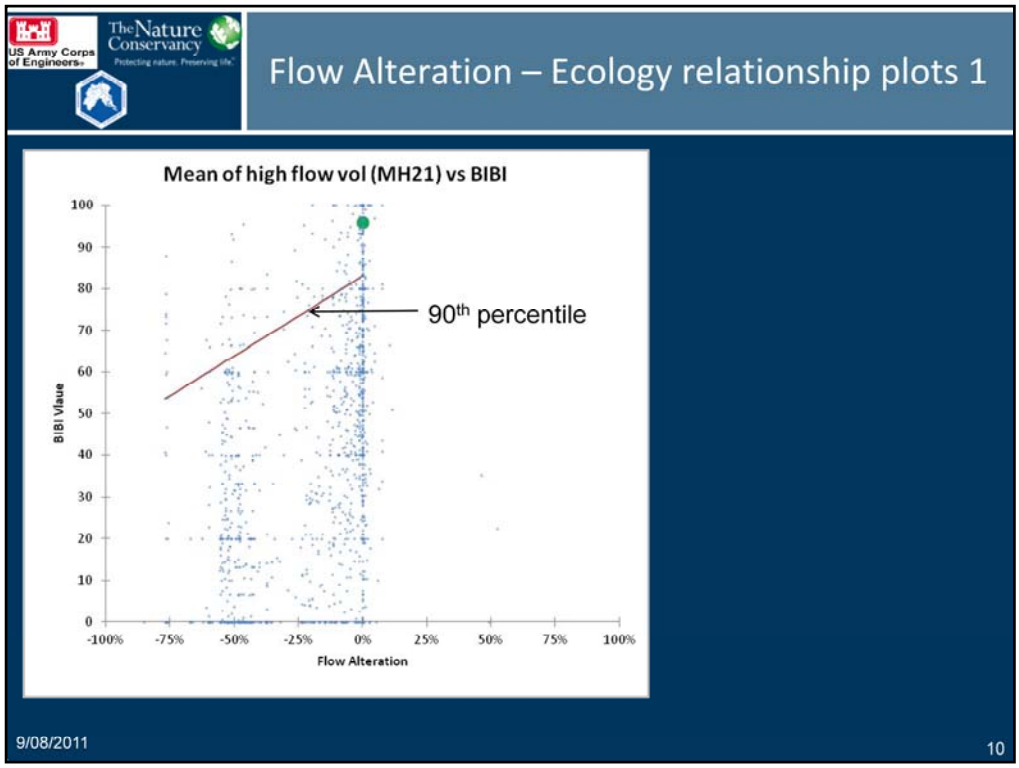
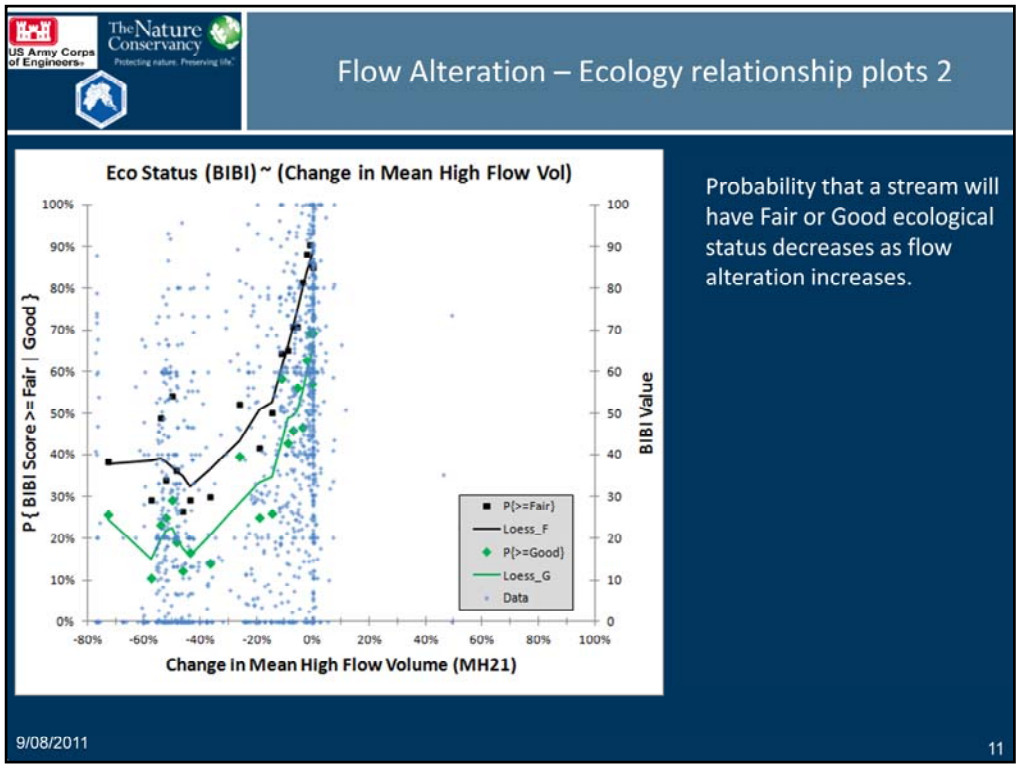


The straight line is a linear 90% quantile regression shows that, as flow alteration increases, the best possible ecological status decrease.

Plot shows that the highest BIBI scores decline as flow alteration increases (Current Mean High Flow Volume progressively lower than the baseline scenario.



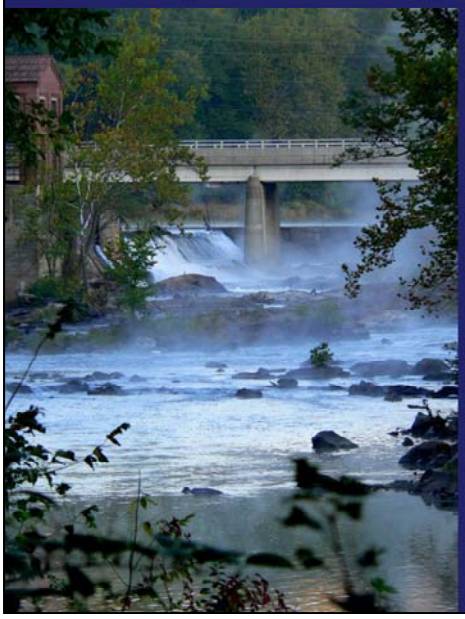
Second type of Flow Alteration – Ecology relationships

Ranges of biometric values have been assigned to health categories Poor – Fair – Good.

Within narrow bands along the X-Axis (Flow Alteration) we calculate the probability that a stream location has Fair or better status (Black) or Good status (Green). The scale is the left side Y-axis and this plot shows that the probability that a stream location has Fair or better, or Good, status decreases as change in mean high flow volume increases.

These are two examples of the Flow Alteration – Ecology relationships that we are developing for the Potomac basin. We are continuing to refine these relationships but we are at the point in this project where we want to start thinking about how they can be applied for water resources management. To kick off that next step, we've asked Colin Apse of The Nature Conservancy to provide us with a sampler of how the environmental flows concept is being applied in other parts of the country.

Environmental Flow Criteria Development: Using Flow-Ecology Relationships in MI and MA



Colin Apse

The Nature Conservancy

Freshwater Conservation Advisor

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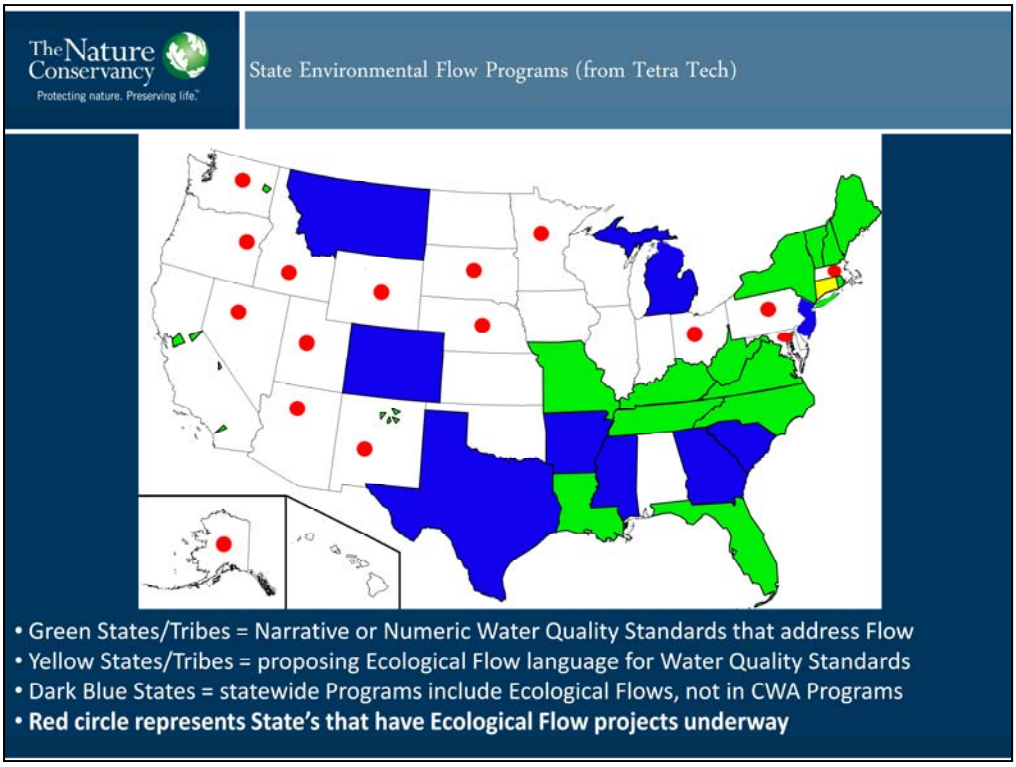

Dark Blue States have statewide Programs with a focus on Environmental flows which may or may not be related to the CWA

Smaller red shapes are Tribes and State sanctioned E-flows programs for specific watersheds

Connecticut has proposed E-flow language as part of their Water Quality Standards

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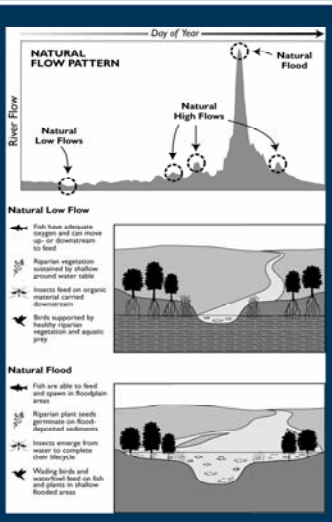
E-flow Policy Implementation

Environmental flow criteria:

Limits on flow alteration, informed by science, and used for management across a state or **basin**

Policy Ingredients:

- Legislative foundation
- Agency expertise & motivation
- Broad stakeholder engagement
- Timing (capitalize on opportunities)
- Impact on existing uses & rates
- **Good science (many ways to get there)**



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Michigan Water Withdrawal Assessment Approach

- Great Lakes water export scare in late 1990s gets public motivated
- Annex 2001 to the Great Lakes Charter, ratified in 2008 in the Great Lakes Compact, stipulates that signatory states may cause:
  - no significant *adverse individual or cumulative impacts* on
  - quantity and quality of the Waters and Water-Dependent Natural Resources of the Great Lakes Basin.

Michigan's 2006 state water law defined "Adverse Resource Impact" as functionally impairing the ability to support "characteristic fish populations"

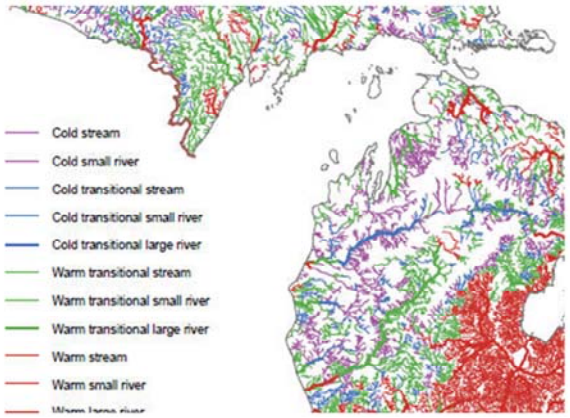
- Law committed the state to create an integrated assessment model to determine potential for proposed withdrawals to adversely impact state resources

Natural System Classification in MI

• Michigan's 5,400 stream segments were classified according to:
  • catchment size (streams, small rivers, large rivers)
  • thermal regime (cold, cold transitional, warm transitional and warm)

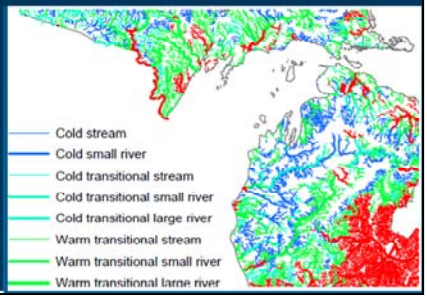
the dominant variables previously shown to influence fish assemblages in MI

• Yielded 11 river types which were mapped onto the Michigan NHD+ stream segment data layer.



Michigan Hydrologic Foundation

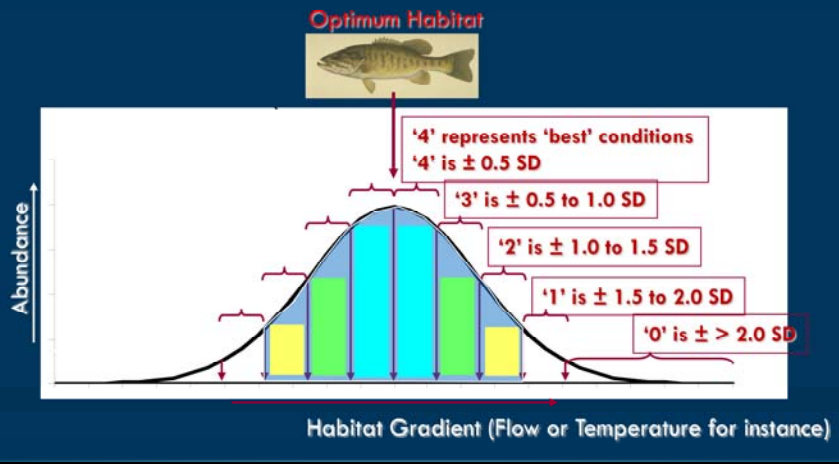
- Hydrologic foundation is a database of median daily flows for the month of lowest flow (typically August) for each stream segment. .
- This "Index Flow" was chosen because it represents the most ecologically stressful period of the year.
- The amount of water that can be withdrawn is expressed as a percent of Index Flow, as suggested by Richter (2009), rather than a min. flow.
- Multiple linear regression using landscape and climate characteristics (aquifer transmissivity, forest cover, average annual precipitation, and soil permeability) estimates the Index Flow for ungaged segments



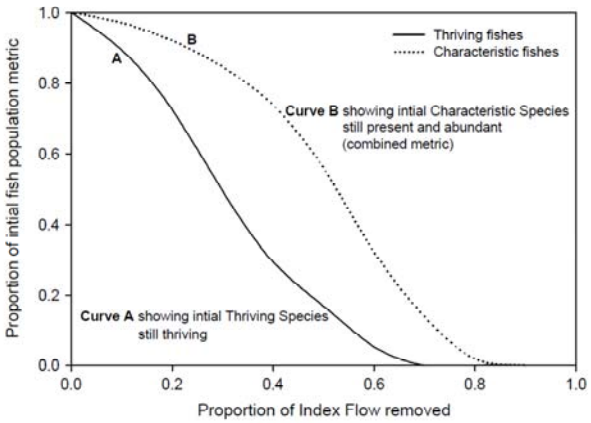
Statewide fish habitat suitability: flow and temperature

Rank scores per normal distribution; 60+ species

Statistical models which predict fish community using data from a representative subset of samples from about 1,700 locations/30 years



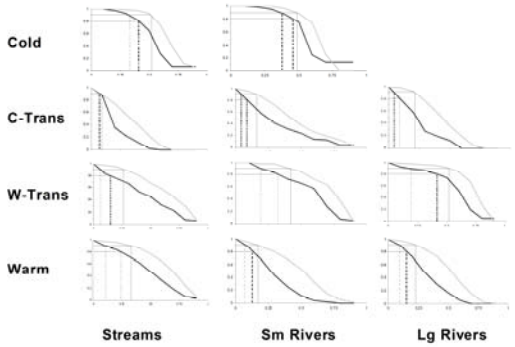
Building Flow-Ecology Relationships in MI



- Curve B= actual decline of fish population functional integrity
- Curve A= most-sensitive, early warning

- Fish response curves that relate population & density changes in characteristic and thriving fish communities to % reductions in Index Flow
- Characteristic populations: assemblage of fish whose habitat (index flow & July mean temp) distributions include habitat conditions for the segment (w/in 1.5 SD)
- Thriving pops: species whole **optimum** habitat is within that segment (w/in 1 SD)

Building Flow-Ecology Relationships in MI

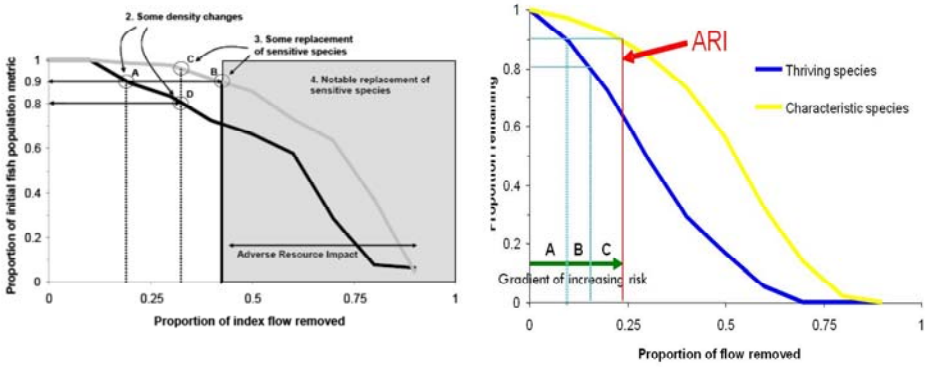


- Fish response curves, for each of the 11 ecological stream types

- Curve from example segments for each type, defining Index flow & July mean temp at the segment, prediction of fish communities:
  - Index flow hypothetically reduced by 10% increments
  - Effects of reduced flow on temperature, and subsequent effect on species abundance

- 22 curves result = thriving (early warning) & characteristic for each of 11 types

Applying Flow-Ecology Relationships to Policy in MI



- To account for uncertainties, state law created "management zones"
  - increasing levels of risk to the environment

- ARI = Adverse Resource Impact, (e.g. 90% of characteristic fish species remaining & replacement of sensitive species)

- Vertical lines are thresholds between water management zones associated with different degrees of ecological change.

- A = issue permit, B = notify local water users, C = site-specific review

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Allowable Percentage Reduction in Index Flow--- Online MI Water Withdrawal Assessment Tool

Ecological Stream Types		Water Withdrawal Management Zones			
		Zone A	Zone B	Zone C	Zone D (ARI)
Cold	Streams	<14%	None	14 – <20%	≥20%
	Small Rivers	<10.5%		10.5 – <21%	≥21%
Cold Transitional	Streams	None	<4%	None	≥4%
	Small Rivers		<2%		≥2%
	Large Rivers		<3%		≥3%
Cool	Streams	<6%	6 – <15%	15 – <25%	≥25%
	Small Rivers	<15%	15 – <19%	19 – <25%	≥25%
	Large Rivers	<14%	14 – <19%	19 – <25%	≥25%
Warm	Streams	<10%	10 – <18%	18 – <24%	≥24%
	Small Rivers	<8%	8 – <13%	13 – <17%	≥17%
	Large Rivers	<10%	10 – <16%	16 – <22%	≥22%

Screening Tool

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Getting to Implementation in Michigan

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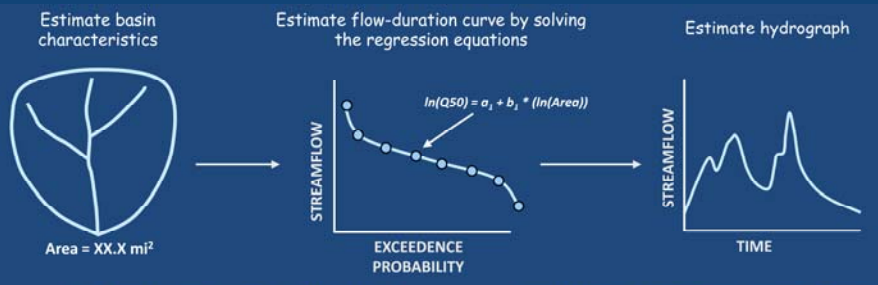
Massachusetts Sustainable Water Management Initiative Process (SWMI)

- Law exists to manage all new & most existing withdrawals w/ permitting
- Droughts led to well publicized issues with existing management → lawsuits

- SWMI to advise state on water management reform
- State and USGS out ahead in science and DSS investment
- Work had influenced & is influenced by ELOHA framework

Ipswich River, MA

Hydrologic Foundation: MA Sustainable Yield Estimator Approach



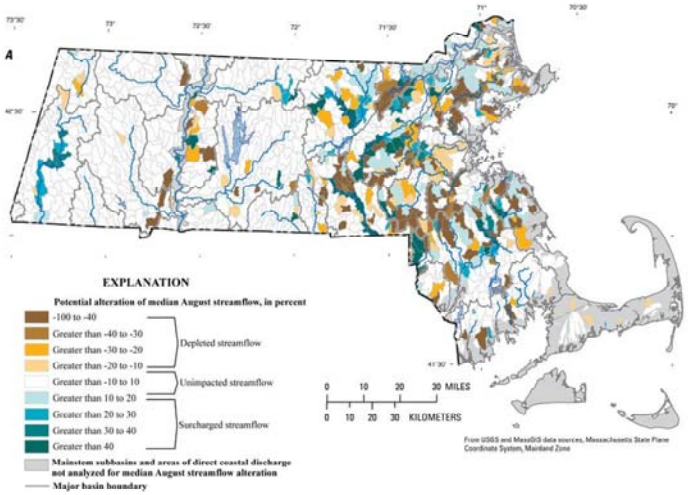
Solve regression equations that relate measurable basin characteristics to flow-duration-curve statistics

Transform the estimated flow-duration curve into a time series of streamflow by use of an index gage

Sources: Archfield and others, 2010.; Ries and Friesz (1999); Fennessey (1994)

USGS science for a changing world

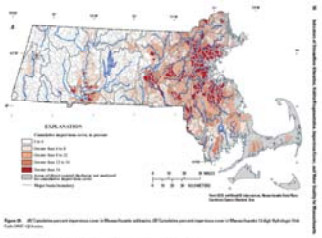
Flow Assessment: unregulated daily flows combined with **state water use data** = estimates of streamflow alteration

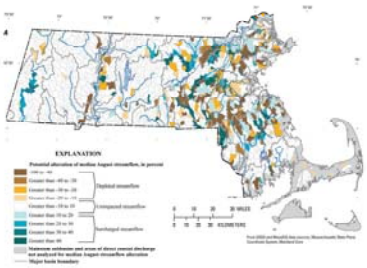


• Lack of reliable water use and return flow data limits states' abilities to do quantitative flow-ecology relationships

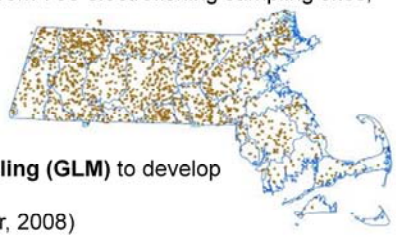
"MA Fish and Habitat Study" (Armstrong et al, 2010)

OBJECTIVE:
Determine relations between fish community characteristics and anthropogenic stressors (August flow alteration and impervious surface) relative to physical basin and land cover characteristics





FISH COMMUNITY DATA:
The Massachusetts Division of Fisheries and Wildlife data from 756 electrofishing sampling sites;



APPROACH:
Used **quantile regression** and **generalized linear modeling (GLM)** to develop flow-ecology response relationships for
- fluvial fish richness & relative abundance (Bain & Meixler, 2008)
- five indicator species metrics

Flow-Ecology Relationships

- *GLM*: Association between fluvial fish relative abundance and August flow alteration & % impervious

  (*along with % wetland, slope, longitude, drainage area*)

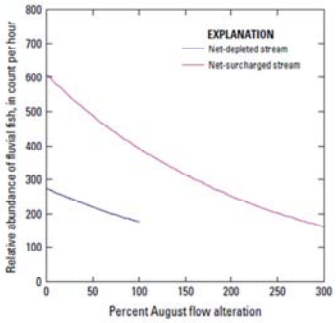
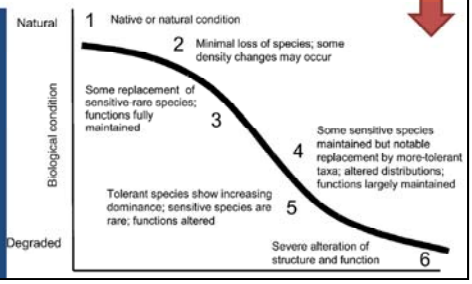
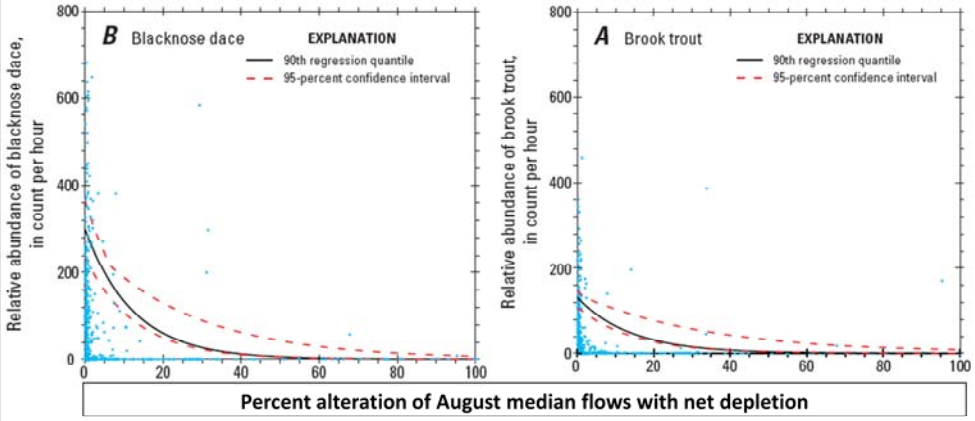


Figure 18. Generalized linear model output for relations between fluvial-fish relative-abundance and percent alteration of August median flow for selected net-depleted and net-surcharged streams in Massachusetts, 1998-2008.



- BCG: Biological Condition Gradient (Davies & Jackson, 2006) for categorization to assist standard-setting

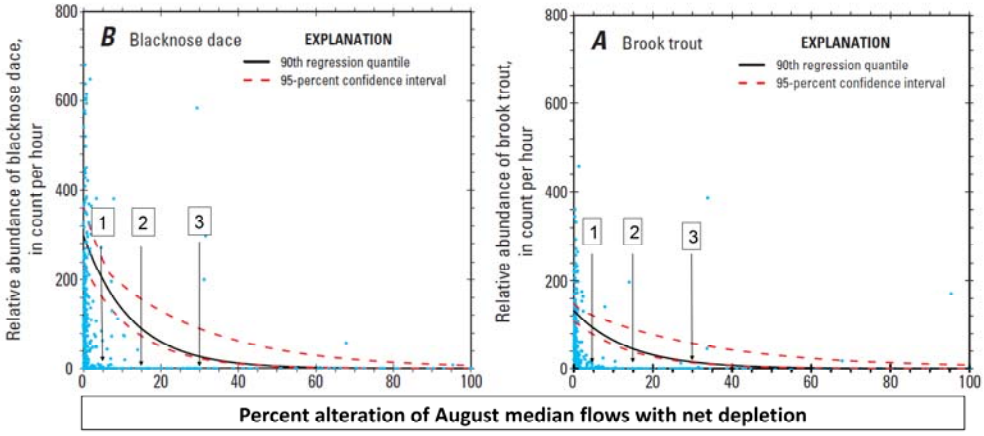
Flow-Ecology Response Relations for MA



Quantile Regression- August median flow alteration (depletion) associated with:

- Large decreases in blacknose dace & brook trout relative abundance
- Moderate declines in fluvial fish relative abundance & species richness
- Little change for white sucker

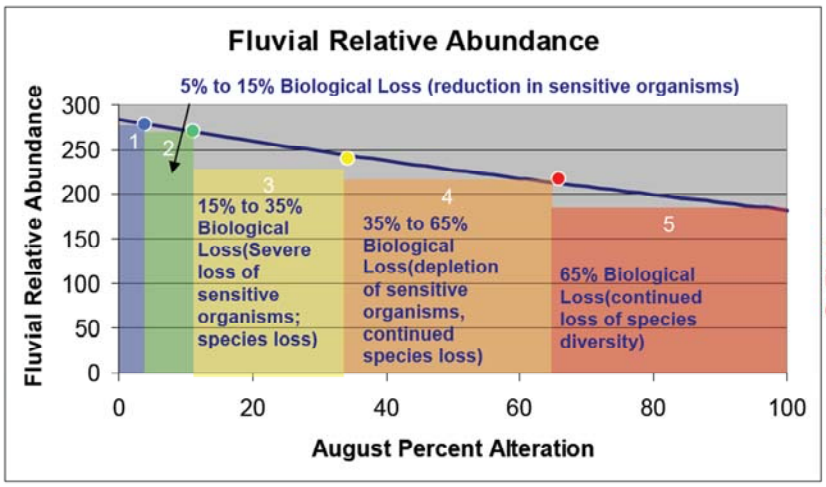
Flow-Ecology Response Relations for MA



Current condition categorization for environmental flow standard-setting:

- Use of quantile regression results, GLM equation, and significant best professional judgment

- 5 categories of ecological condition using the BCG framework (3 depicted)



*assumes 1% impervious cover

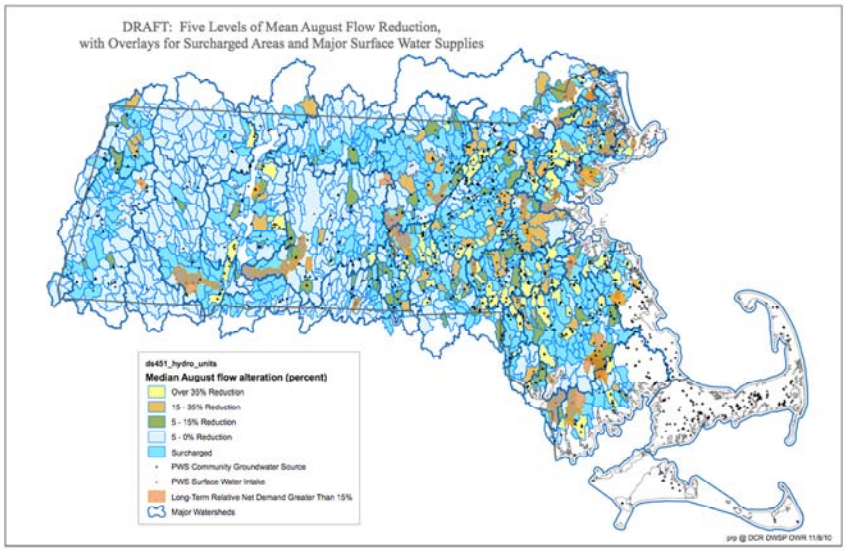
•GLM serves as basis for assessing current condition category or "flow level" at subbasin scale statewide

• 5%, 15%, and 35% biological loss approximately = 5%, 15%, and 35% August flow alteration

• Impervious held constant since not directly regulated by the state

• **Flow-alteration based classification can be applied statewide (1400+ sub-basins) using SYE**

• **Starting point for application of streamflow criteria – criteria to take into account overall biological condition & streamflow status**



Draft MA Environmental Flow Criteria

- Flow criteria from August extrapolated to other "bioperiods" using relationships between monthly flows and expert opinion
- Flow criteria would apply during new permits or permit renewal
- Site-specific study or mitigation likely options for modeled violations

Stream Flow Criteria

Fluvial Fish Relative Abundance	
Biological Category (BC)	August Percent Alteration
1	< 5%
2	< 15%
3	< 35%
4	< 65%
5	> 65%

	% allowable alteration of estimated unimpacted median flow*			
Flow Level (FL)	AUG	OCT	JAN	APR
1	< 5%	< 5%	< 5%	< 5%
2	< 15%	< 5%	< 5%	< 5%
3	< 35%	< 15%	< 15%	< 15%
4	Feasible mitigation and improvement			
5				

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Summary Thoughts for Discussion

- No one approach to flow-ecology relationships
  - Requires judgments call on science, expert workgroups
  - What will be accepted by stakeholders/policymakers
- Statewide examples focused on flow metrics that do not encompass full range of flows
  - Potential area of innovation in Potomac
  - Also Susquehanna study approach to filling gaps
- In the Potomac, important to provide results to fit the audience
  - Small set of comprehendible relationships
  - Environmental flow criteria would be set in a separate process

The Middle Potomac Watershed Study is different

1. Interstate basin
   a) No single regulatory authority
   b) Each jurisdiction in a different "place" with respect to applying environmental flows to management
   c) Challenges in developing databases consistent across all states

2. Meeting the technical challenges has determined our choice of modeling framework, target biota, and time frames and methods for defining current and baseline conditions.

3. Addressing the multi-state framework of water management in the basin means that results from this study will be offered as support to existing or pending state environmental flow initiatives.

Coming up:

-Completing the development of FA – E relationships

- Workshop – intensive review of methodology for FA- A relationships and discussions about potential applications

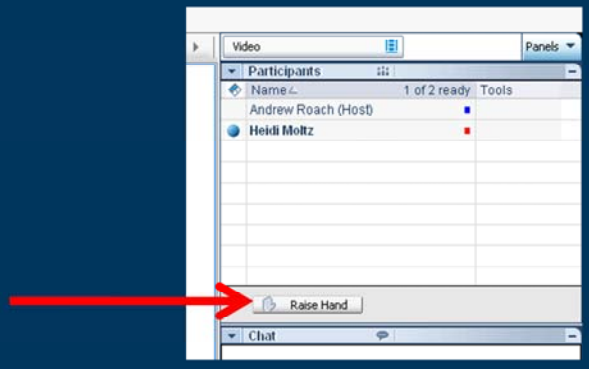
-- meet with state agencies to explain results and discuss potential applications within existing state environmental flow intiatives.

Changes:

1) Nov workshop 2 days only, intended for Technical Advisory Group and some others. Focus will be on science of FA-E relationships. Invitation only.
2) New, 7th, webinar planned to share the workshop findings and recommendations with all stakeholders.
3) We recognize that all the watershed jurisdictions have either ongoing or planned/desired flow analyses related to water resources management. Briefings for state agencies planned for Dec.-Jan. to discuss how these results can be applied to their water planning processes.

Questions? Comments?

- Raise your hand by clicking on the button on the webinar menu.
- Please remain muted until the conference organizer calls on you.
- Once called upon, un-mute your phone by selecting *7.
- Afterward, please mute your phone again by selecting *6.



Post Webinar Follow-up

Contact for this webinar

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More info about project and copy of this webinar's slides

- http://potomacriver.org/sustainableflows/