Data Collection and Analysis to Determine Instream-Flow Needs:

Jennifer Krstolic, USGS, Richmond, Virginia

What are Instream-Flows?

- Instream-flow techniques can be used to help reserve water within the channel for the benefit of fish and other aquatic life. Research took the form of analyses correlating the well-being of fish populations with physical and chemical attributes of the flow regime.

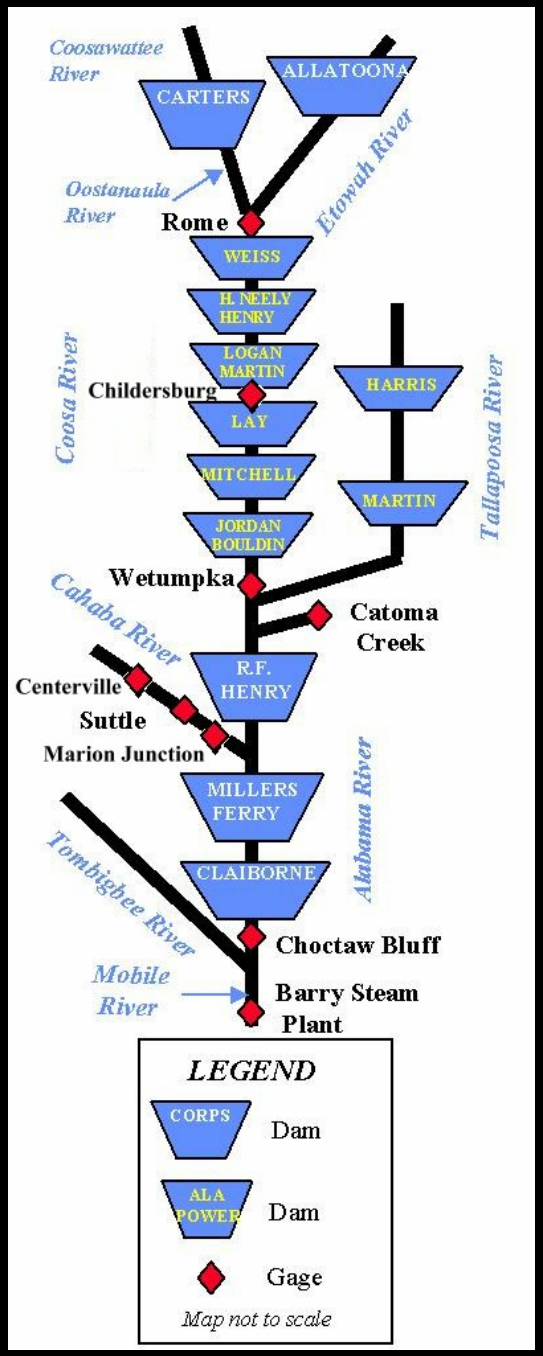
- The result can be a single 'minimum' flow value for a stream reach, below which water may not be withdrawn for consumptive use.

water velocity
water depths
instream objects as cover
bottom substrate materials
water temperature
dissolved oxygen
total alkalinity
turbidity
light penetration through the water column

Instream-Flow Studies are Used to Study and Manage Habitat in Altered Systems

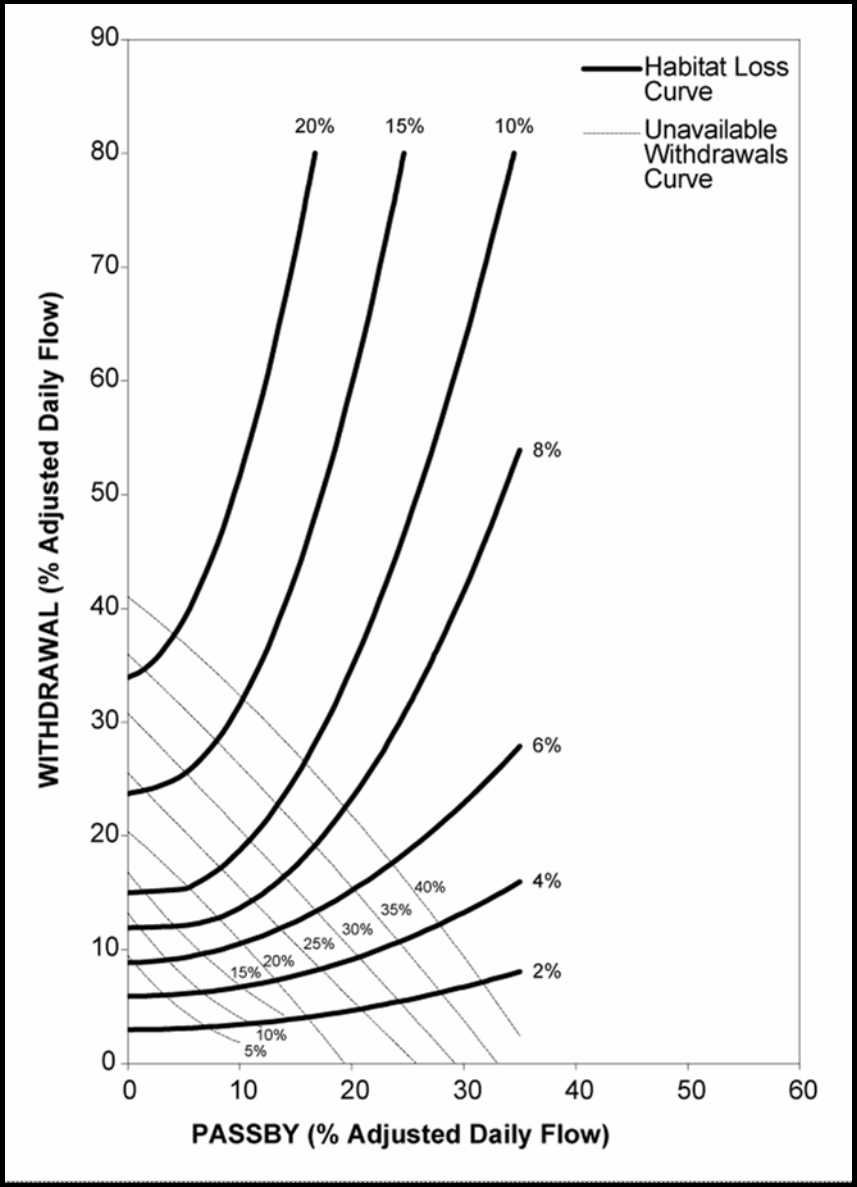
Active Projects of Patuxent Wildlife Research Center, Athens Georgia:

- **Technical Assistance in developing an adaptive approach to hydropower management**
- **Effects of instream flow depletion on biological integrity of fish communities**
- **Technical Assistance in assessing and developing instream flow and river management policies**
- **Relations between stream biotic integrity and proportion of annual surface water runoff allocated for human use**
- **Conservation status of fish and other aquatic resources in the upper Tallapoosa River system, Georgia and Alabama**
- http://www.pwrc.usgs.gov/freeman.htm



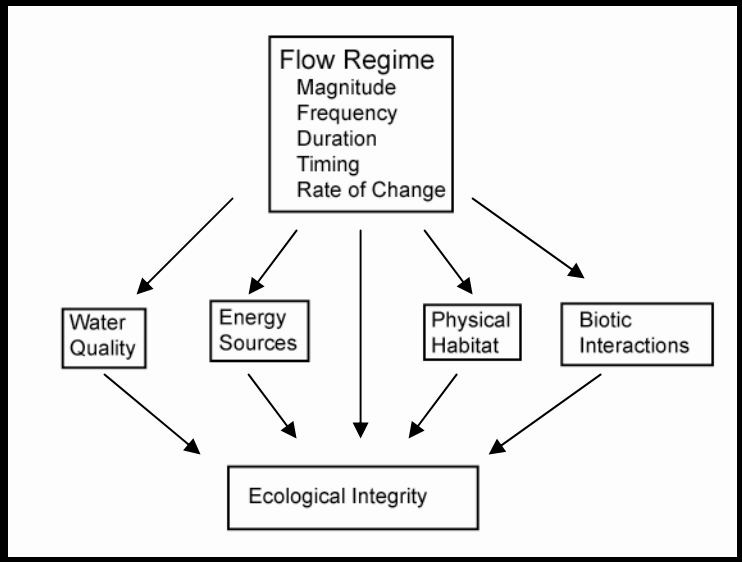
Instream-Flow Model for Pennsylvania and Maryland Trout Streams

- Hydraulic models developed for more than 100 sites on 72 streams
- Model will predict effects of withdrawals on trout habitat
- Considering ground-water pumping effects on streamflows in permitting process
- www.dep.state.pa.us/dep/deputate/watermgt/Wc/subjects/InstreamFlow.htm



Natural Flow Regime, a Paradigm for River Conservation and Restoration

- N. LeRoy Poff and others, 1997
- *The ecological integrity of river ecosystems depends upon their natural dynamic character*
  - Magnitude and Frequency
  - Timing
  - Duration
  - Rate of Change



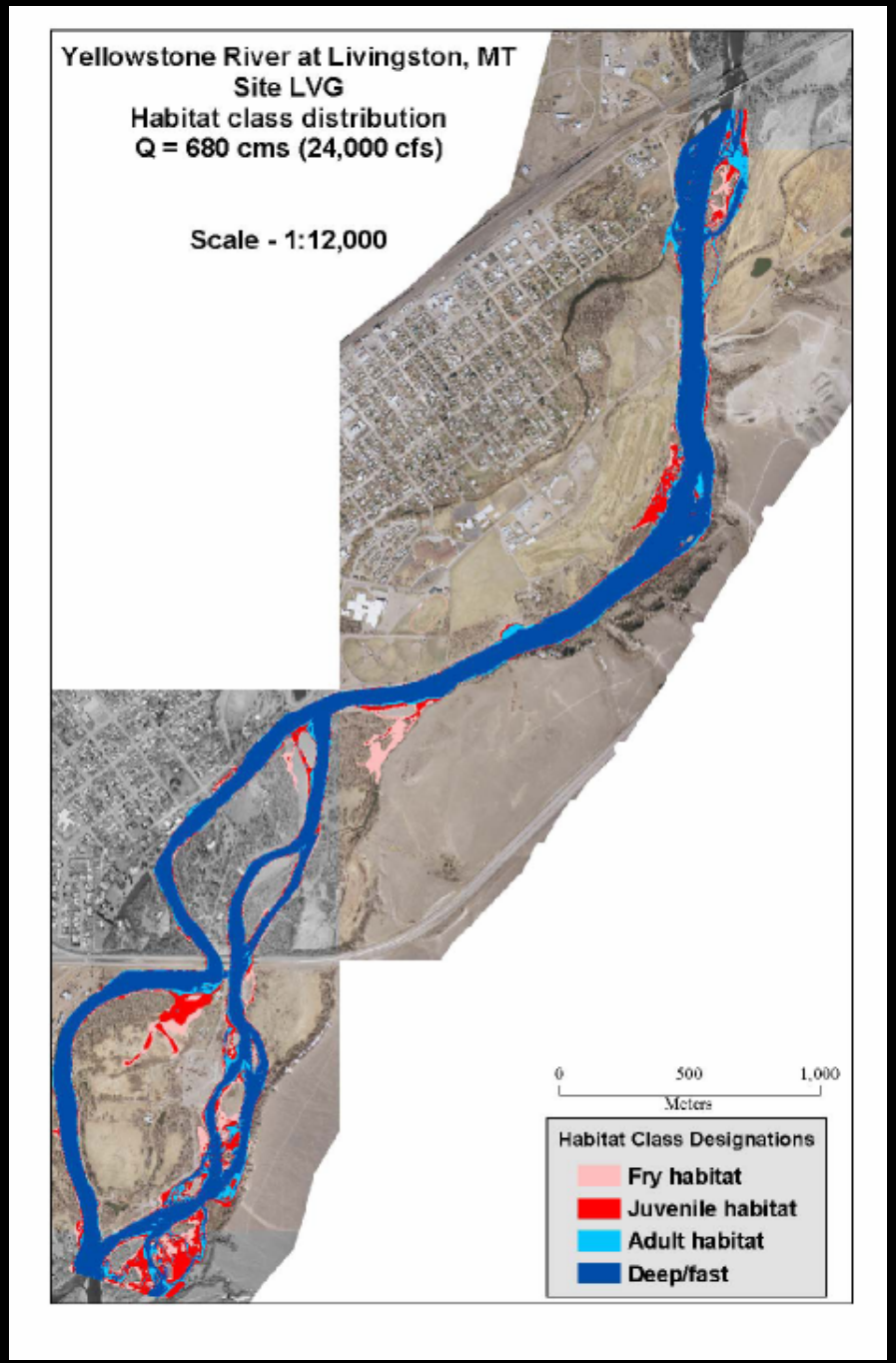
Additional References:
http://lamar.colostate.edu/~poff/natflowrefs.html

USGS

Effects of Channel Modification on Fish Habitat in the Upper Yellowstone River

- Zachary H. Bowen, Ken D. Bovee, Terry J. Waddle

- www.mesc.usgs.gov/products/publications/21196/21196.asp



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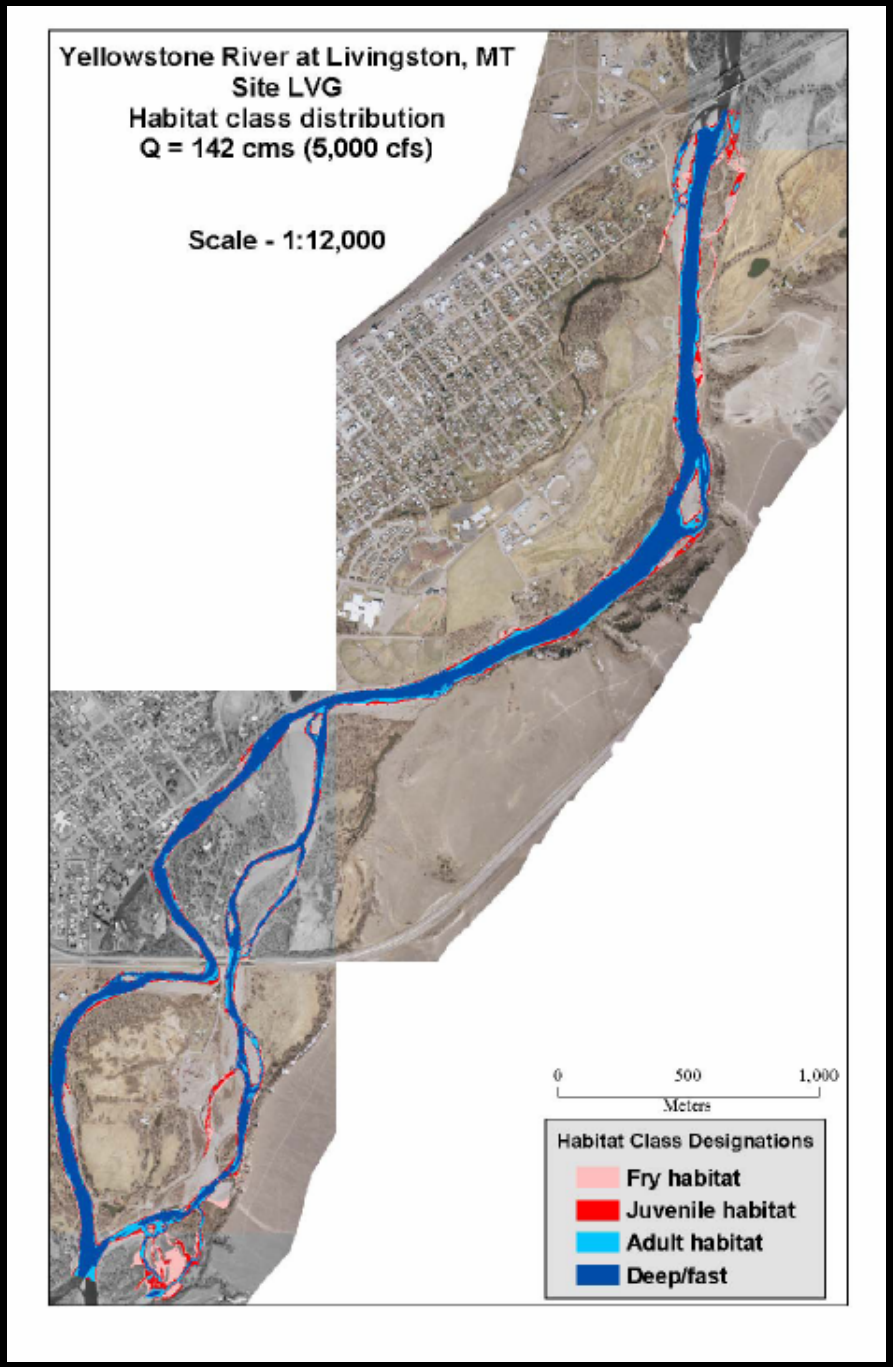

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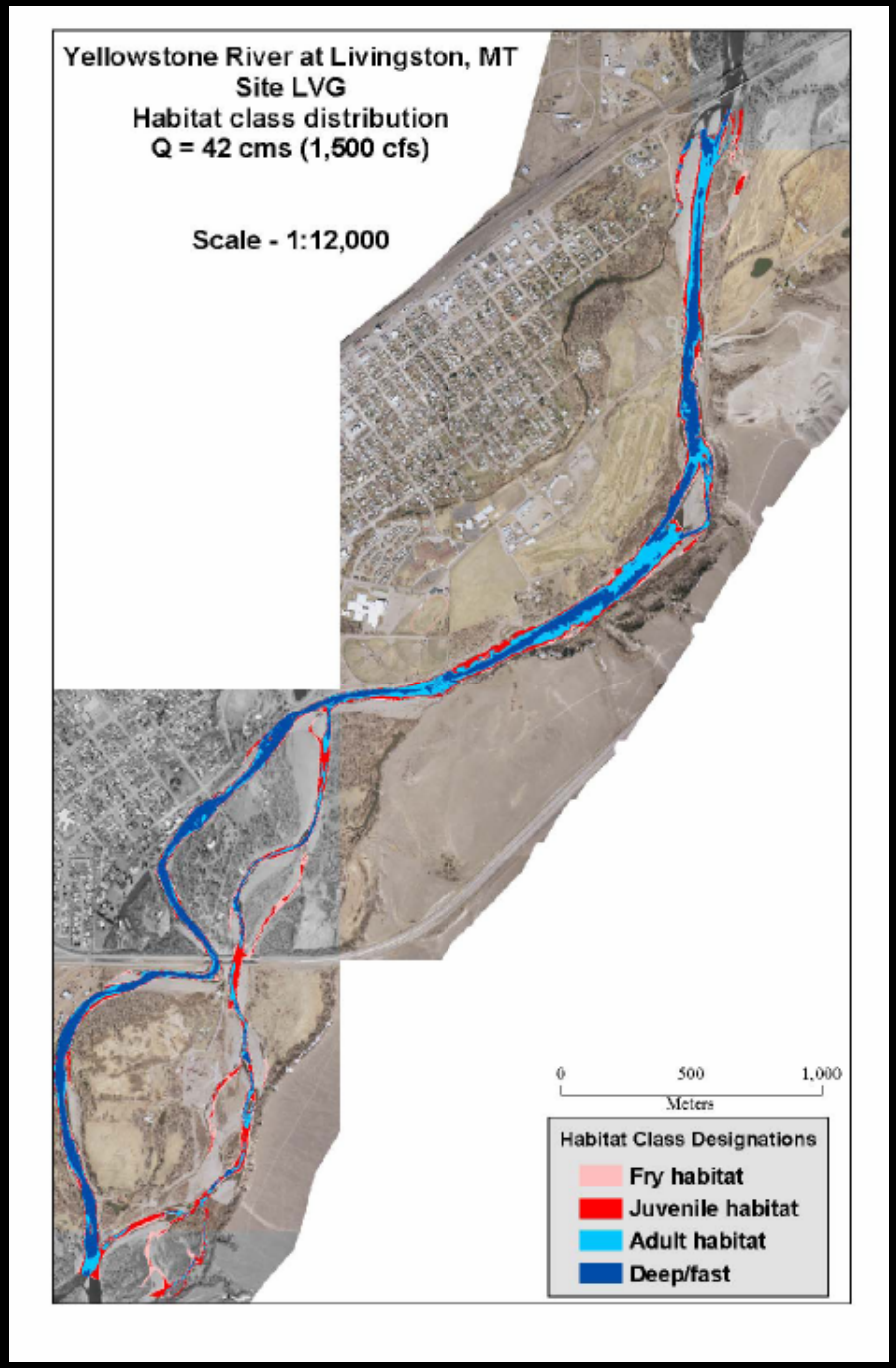

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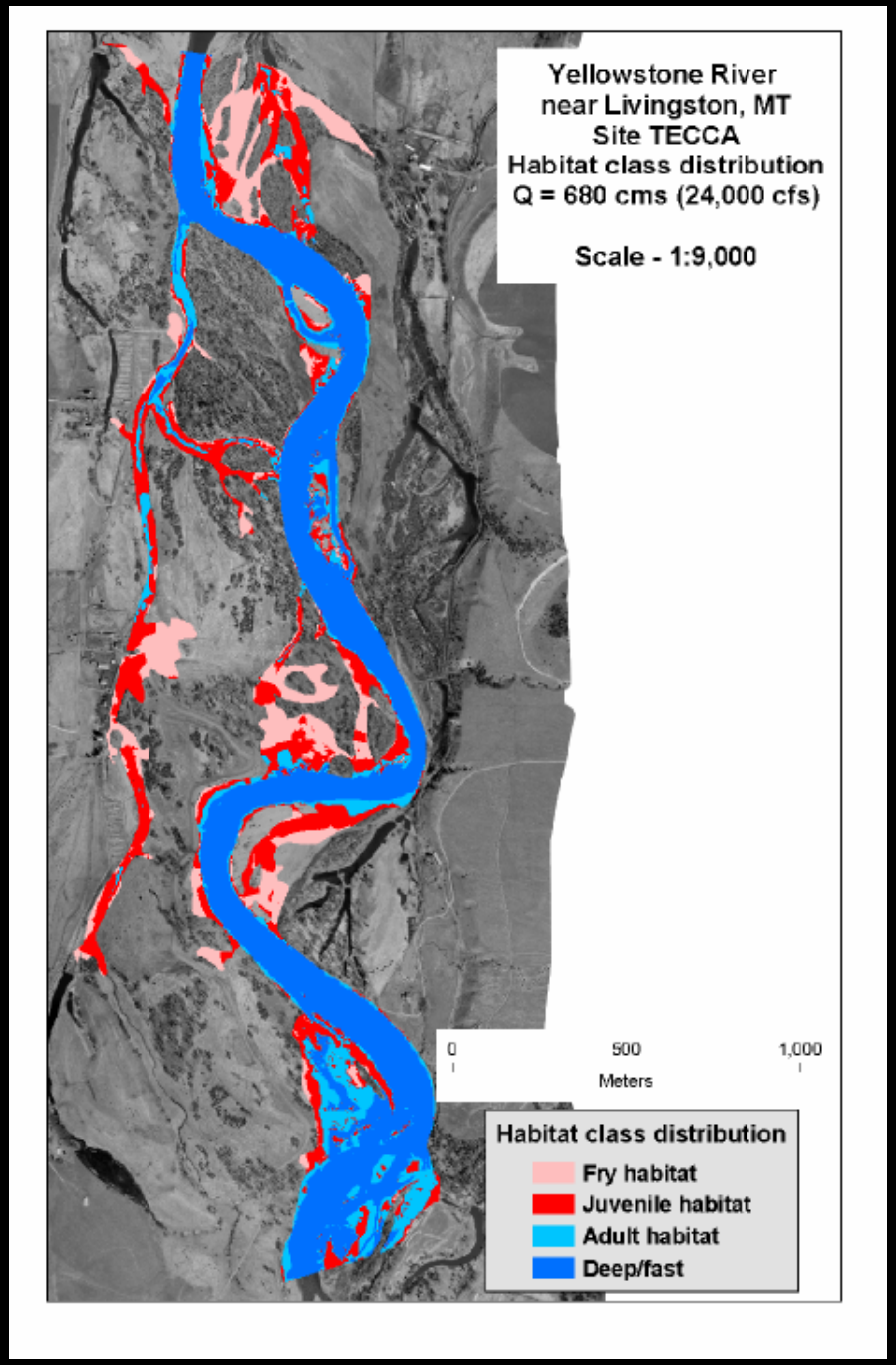

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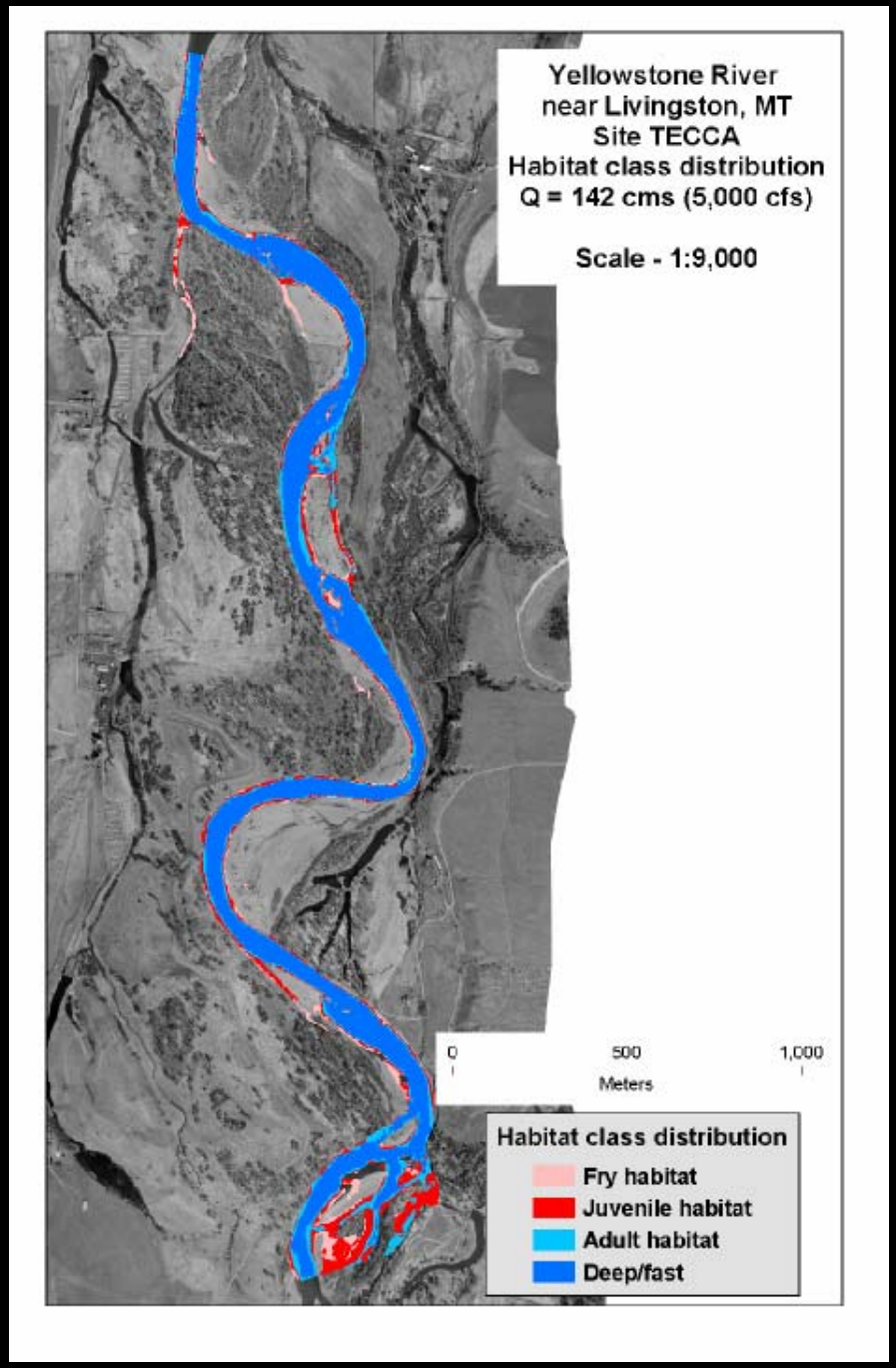

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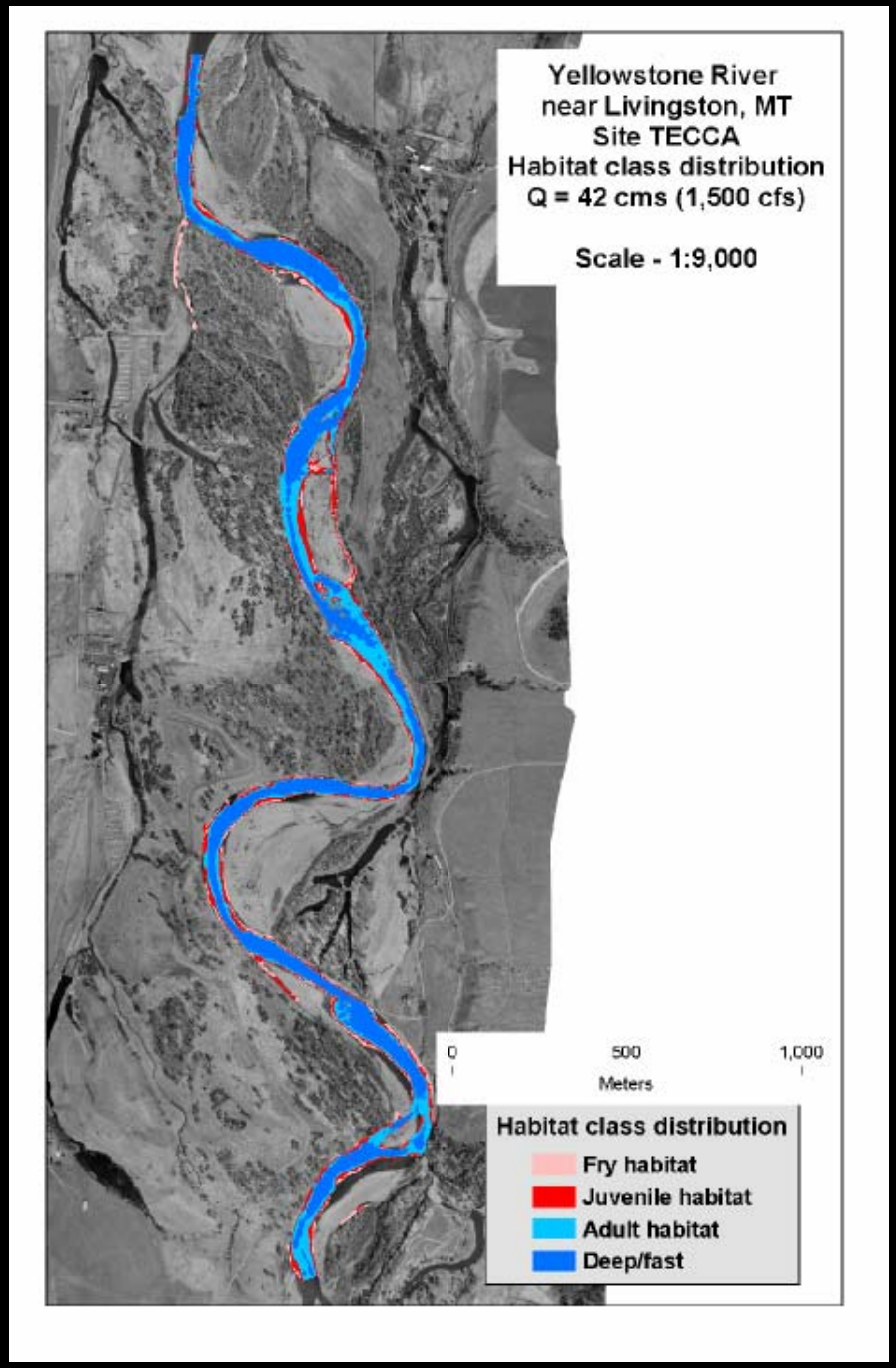
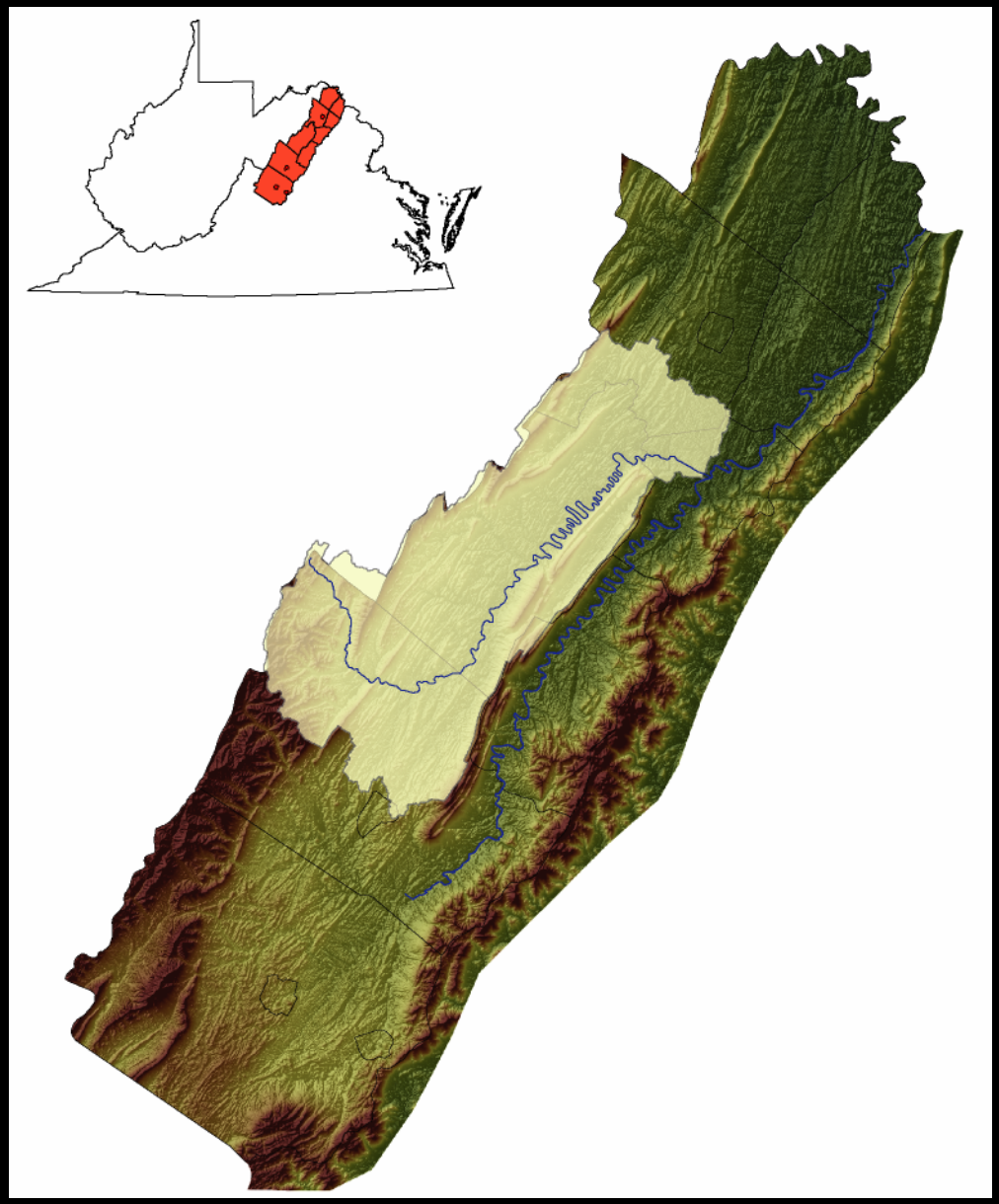


Instream Flow Incremental Methodology Study of the North Fork Shenandoah River, Virginia



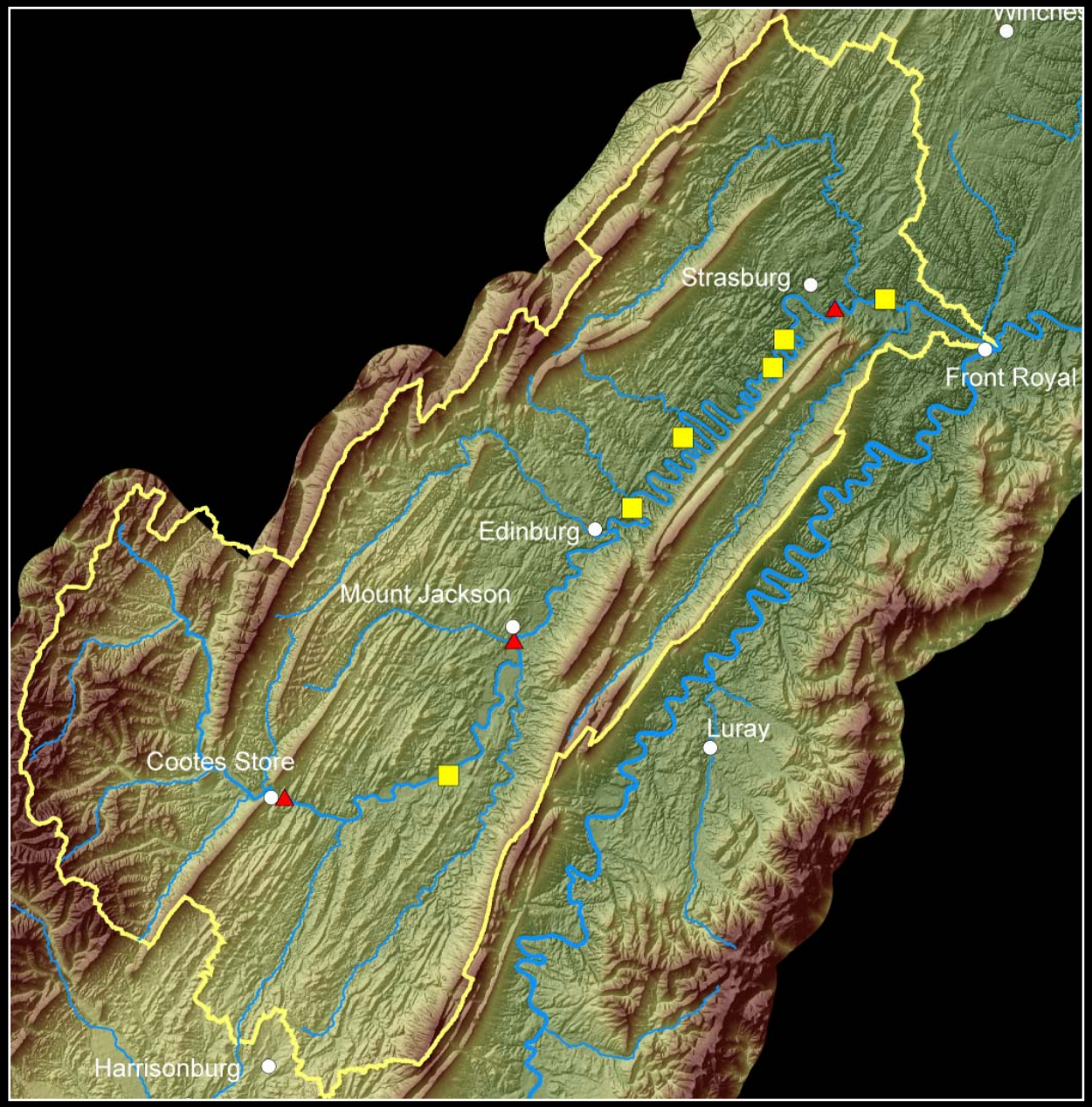
Jennifer L. Krstolic, Donald C. Hayes, and Peter M. Ruhl

In cooperation with:

The Northern Shenandoah Valley Regional Commission

USGS

North Fork Shenandoah River Study Sites and Stream Gages

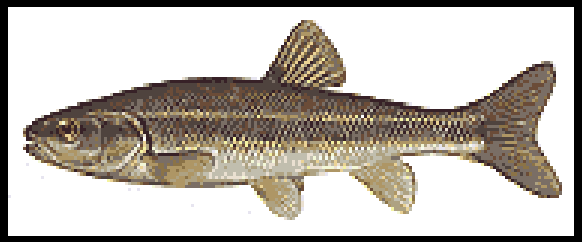
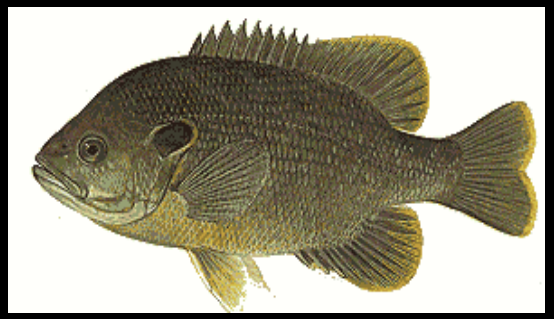
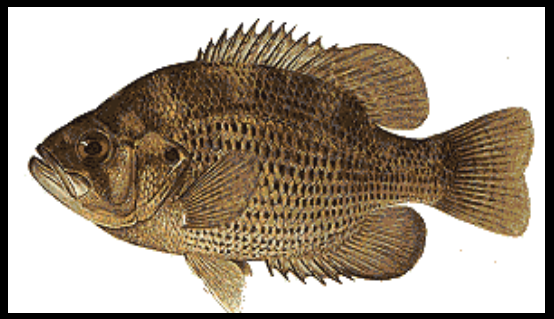
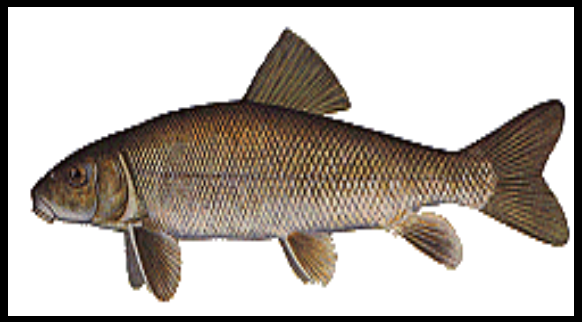


Mesohabitat Classification

- runs (67%), pools (19%), riffles (14%)
- Riffle –generally less than 1 ft. deep; broken water surface; fast velocity; Bedrock, Particle substrate
- Run – 1 to 4 ft. deep; surface is not broken by the bed substrate; moderate velocities; Bedrock, Particle substrate
- Pool –greater than 4 ft. deep; reduced velocities; Artificial and Natural

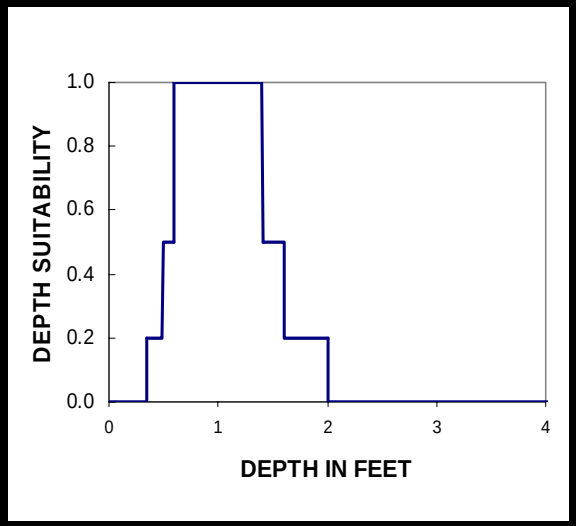
Fish Community Assessment

- Fish were grouped into guilds of species and life stages with similar habitat requirements.
  - Depth, velocity, substrate, and cover
- North Fork Shenandoah River Fish Community:
  - 37 species, 4 guilds
  - Riffle Guild, Fast-Generalist Guild, Pool-Run Guild, Pool-Cover Guild

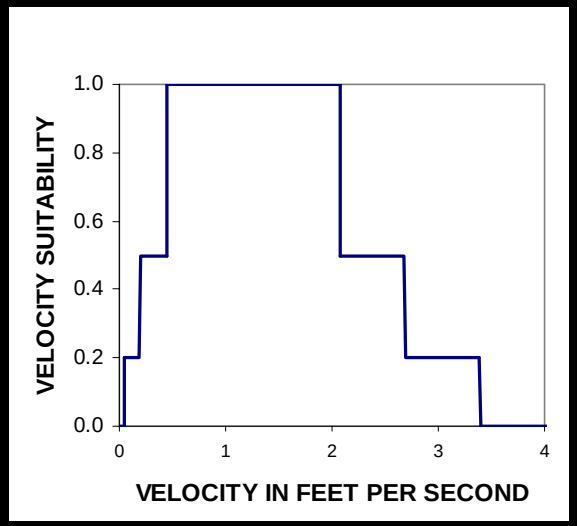





Fish Habitat-Suitability Curves

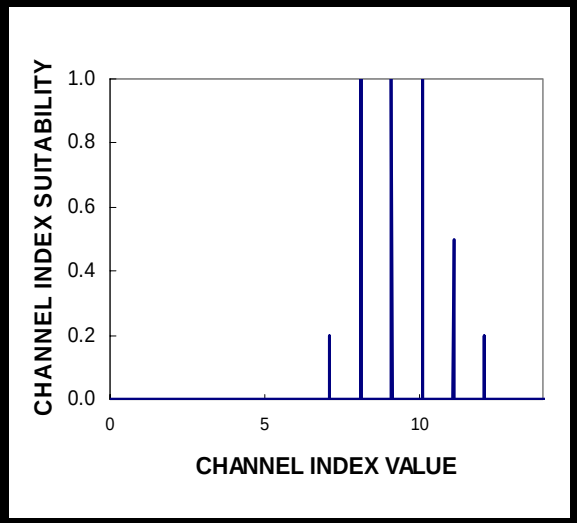
Depth



Velocity



Substrate Channel Index

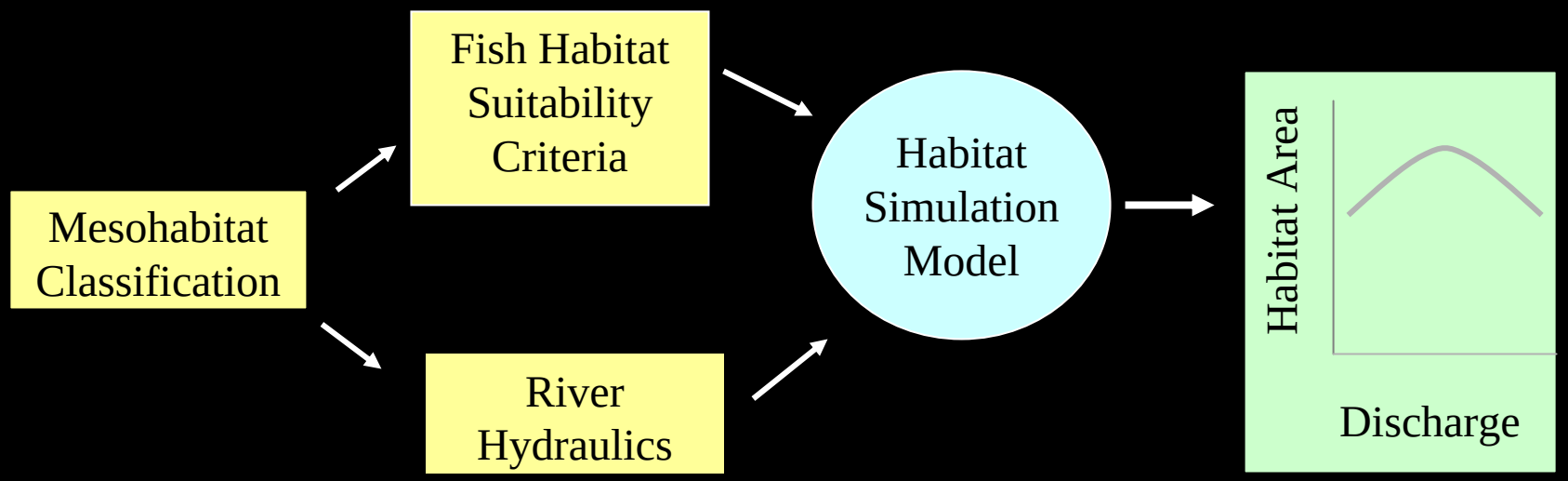


Habitat-suitability criteria (HSC) of fish are based on detailed fish community sampling, habitat observations, and critical analysis of data. The HSC curves represent the physical habitat needs of fish within the North Fork Shenandoah River, and were used in the modeling phase of this research.

Hydraulic-Data Collection

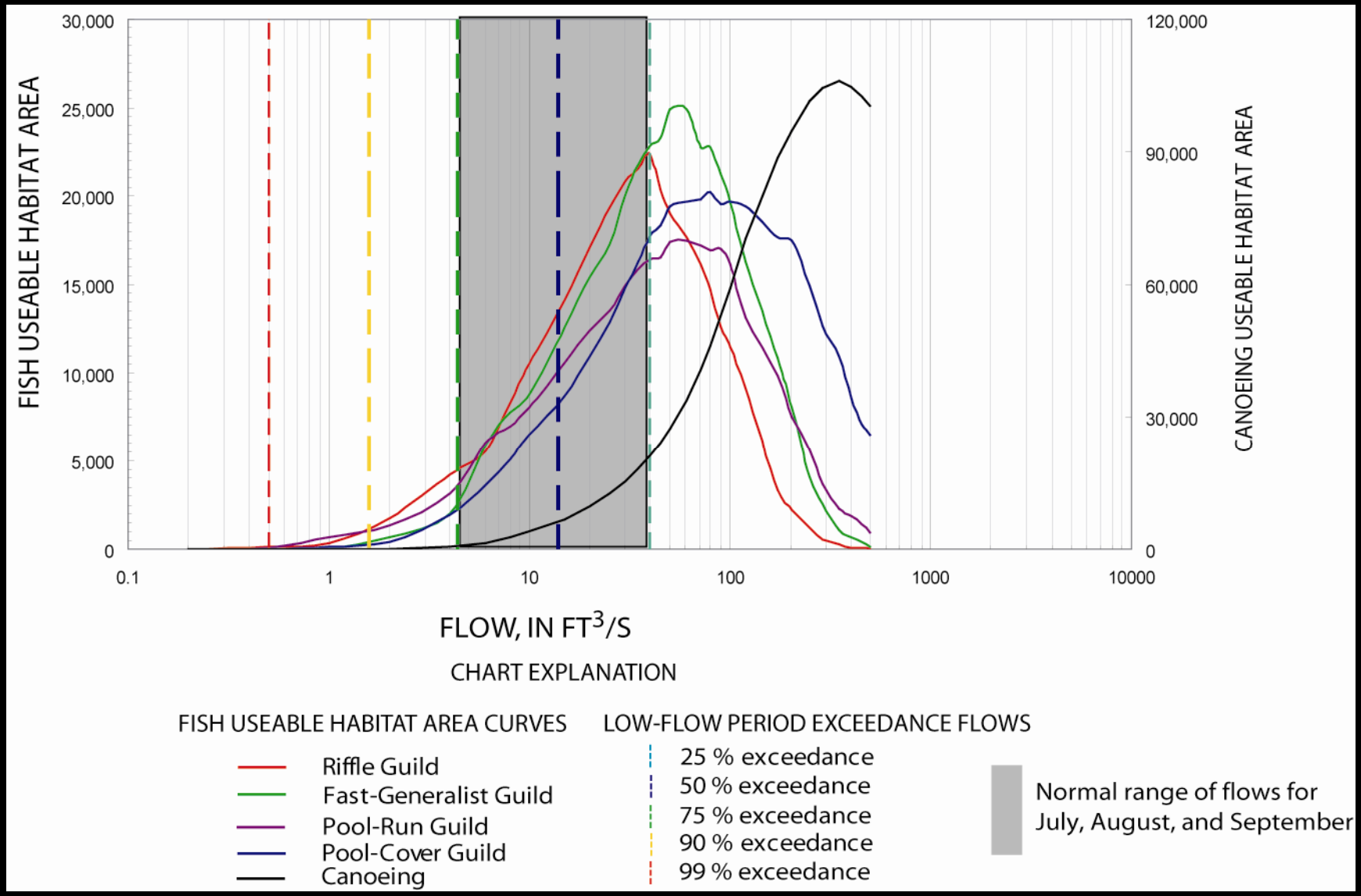
- 6 sites, 36 cross sections
- Measurements at low, medium, and high flows
  - Reach discharge
  - Water surface elevation
  - Depth, velocity, and substrate

RHABSIM Predictive Model

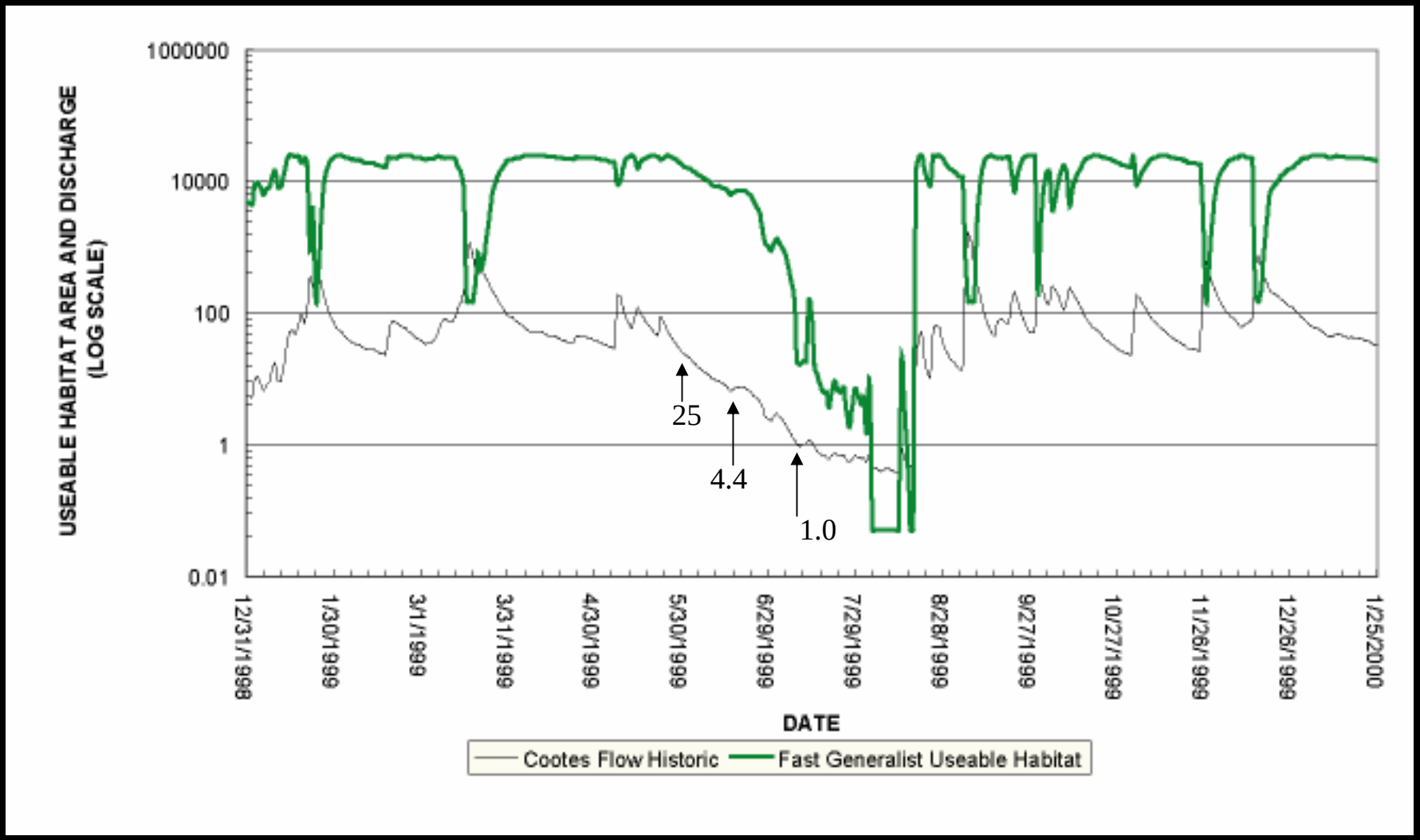
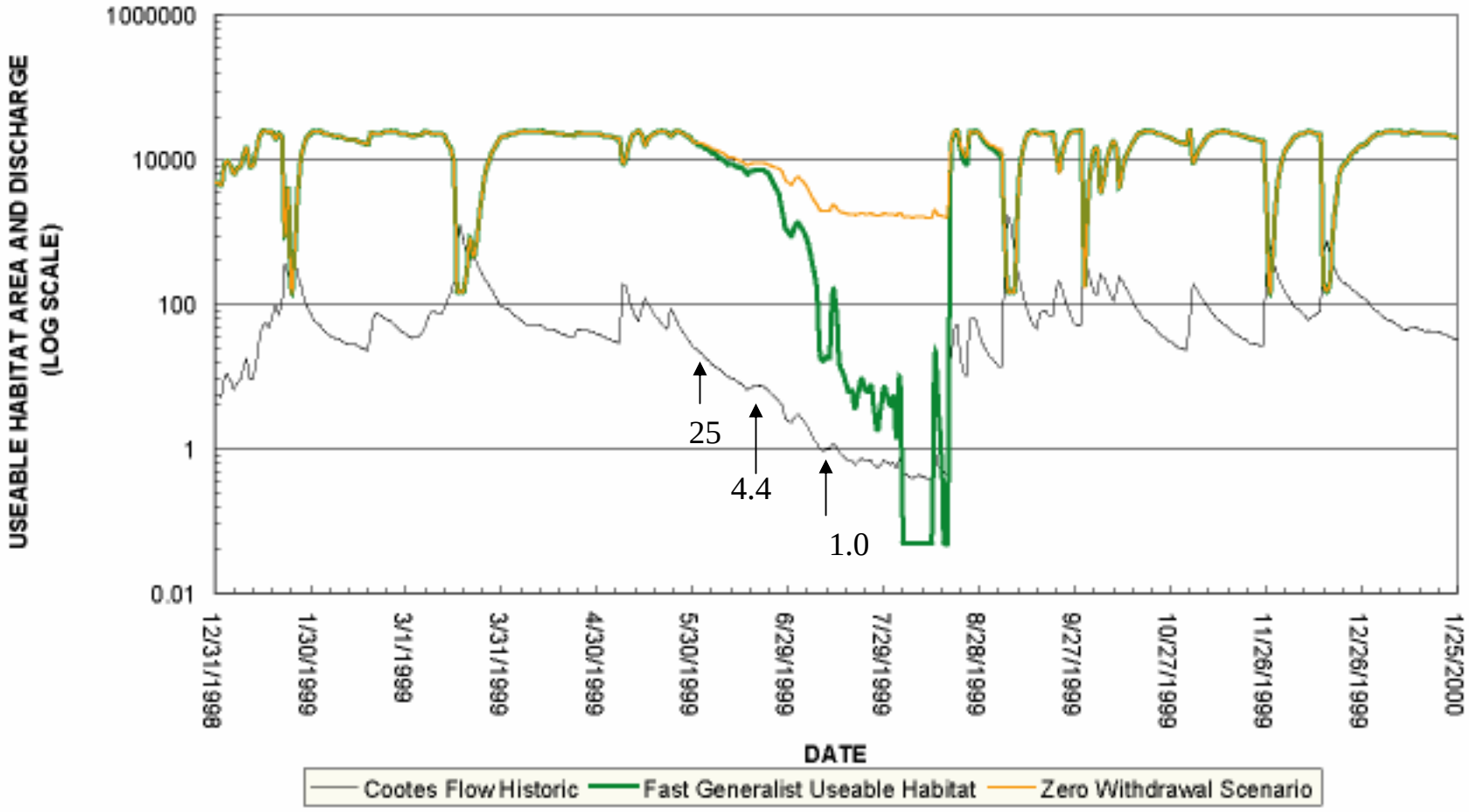


RHABSIM model used to evaluate fish HSC against observed and simulated depths, velocities, and channel index values for each site. Composite habitat suitability rating assigned to each model cell, cross section, and reach for 30 simulated flows.

Habitat-Flow Relation for the Upper River Section



Fast-Generalist Guild 1999 Time Series



Reduced Water-Withdrawals Scenario