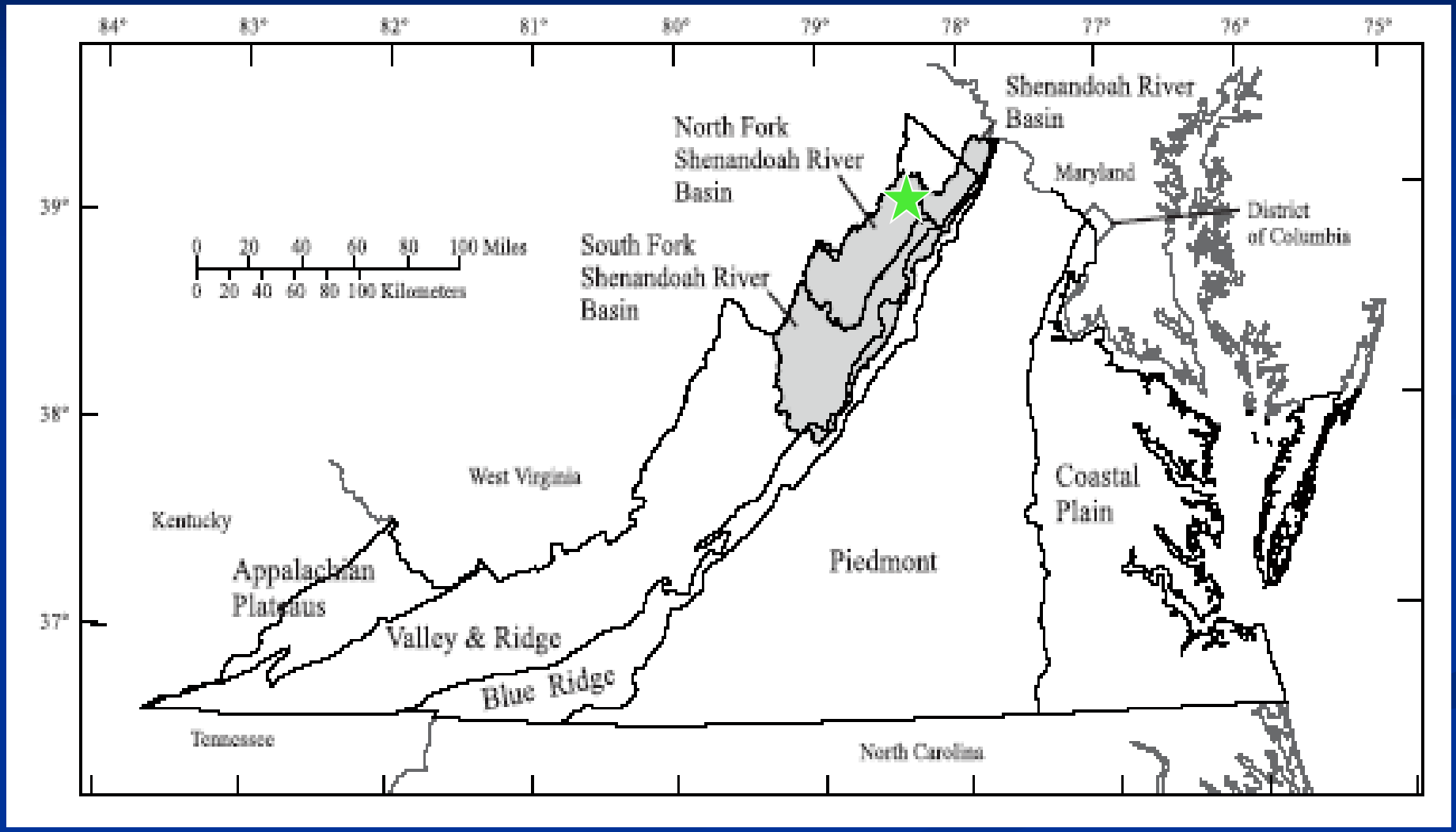
Environmental Flows

John Staelin, Board of Supervisors

Shenandoah River Watershed

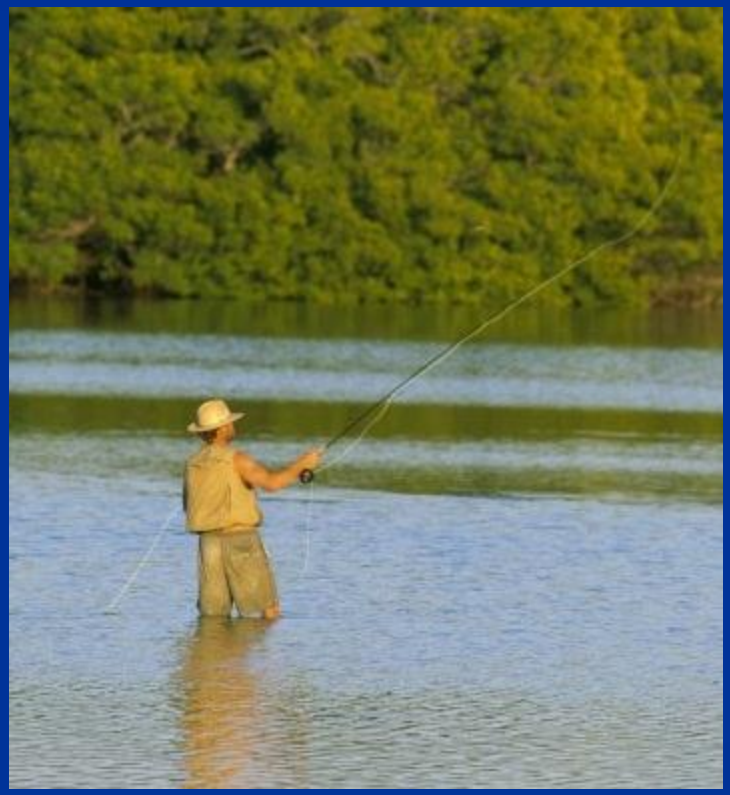


Purpose

- Why are we concerned about instream flows
- What are we doing about it

Why Important -Valuable Fishery

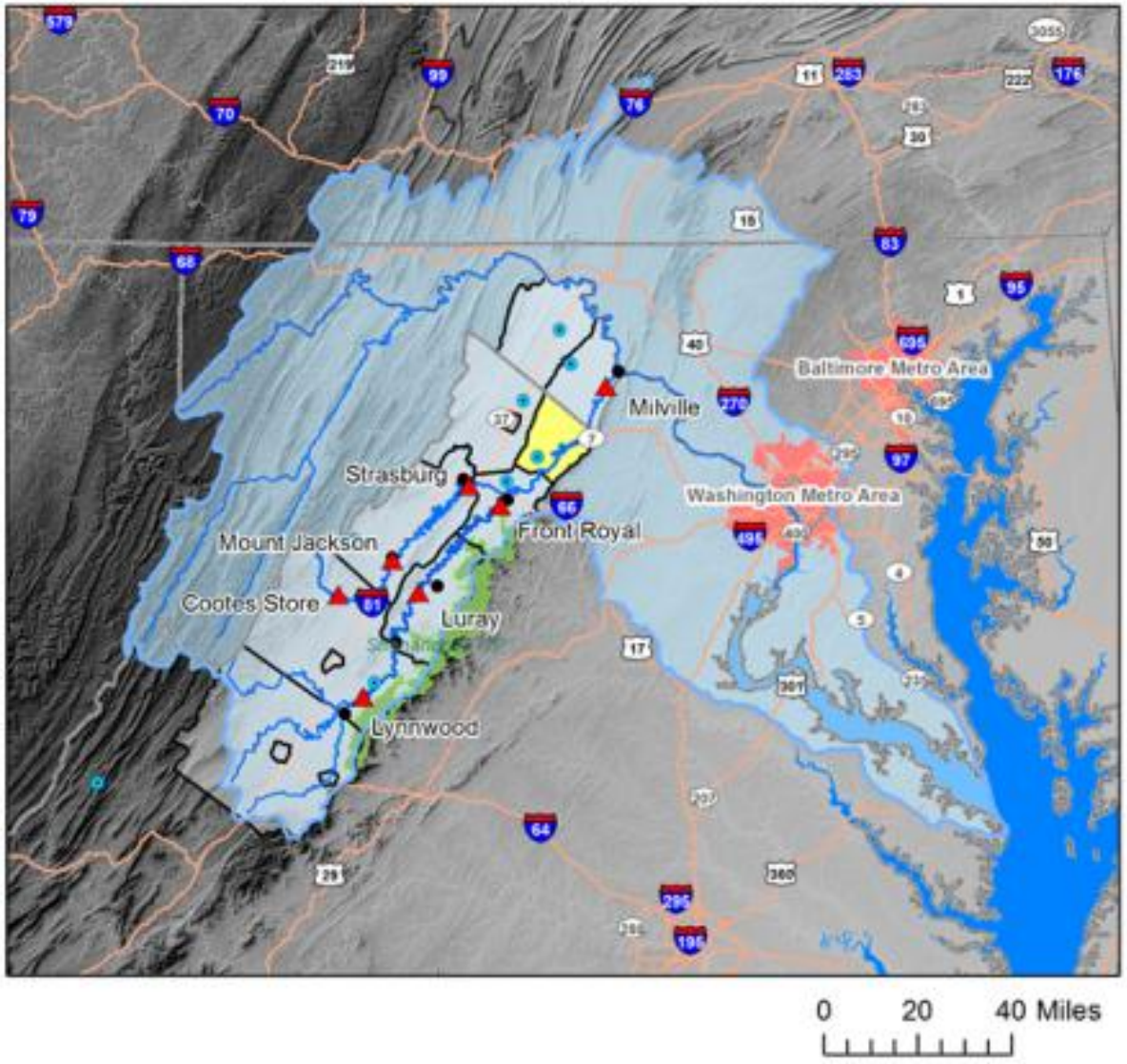
"Serious smallmouth anglers know the Shenandoah River is one of the top smallmouth bass rivers in the eastern United States" (VA Dept. Game & Inland Fisheries)

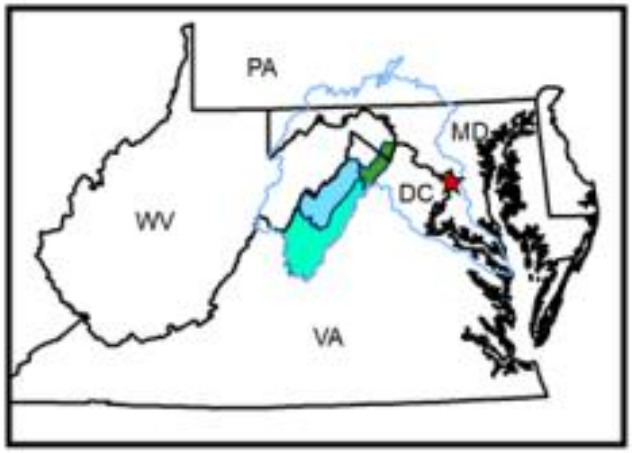


Why Important - Tourism

- Big money maker in Valley
- Economic health dependent on minimum flows

Shenandoah Valley located near major metropolitan areas





Explanation

- Streamflow gaging station
- Real-Time Wells
- Major Rivers
- Shenandoah Counties
- Clarke County
- Potomac River Watershed

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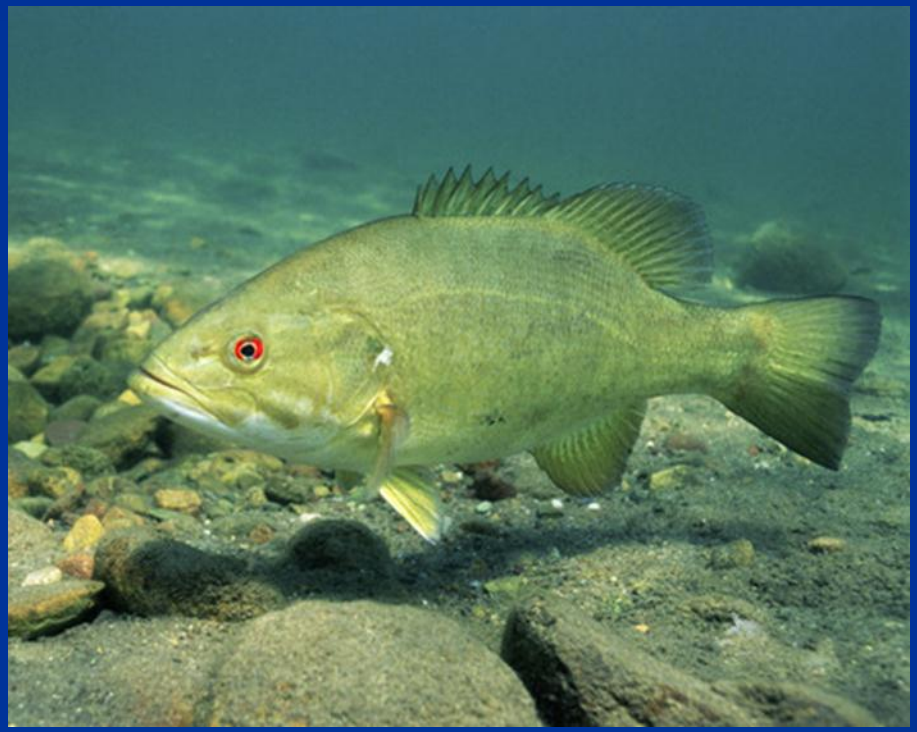
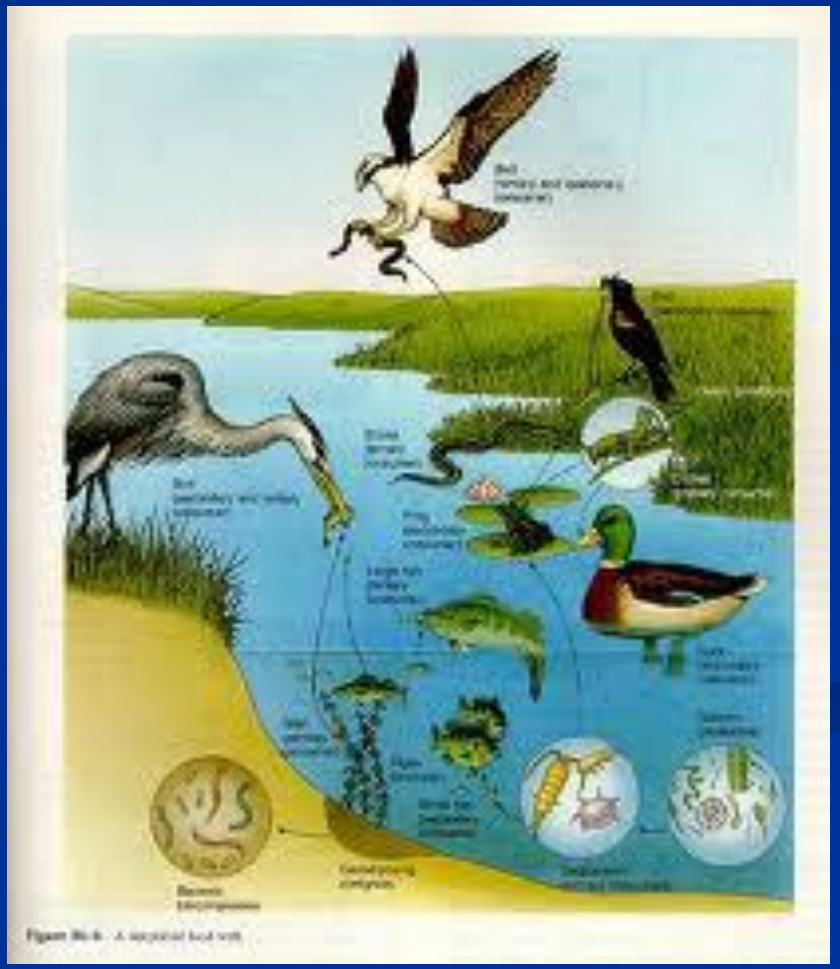
Why Important: Aquatic Ecosystems

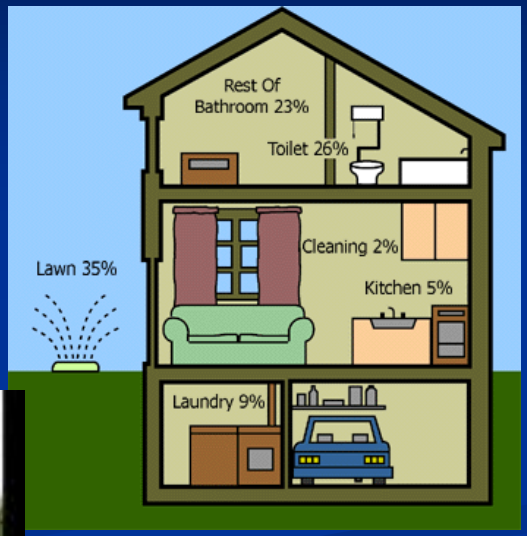
- Fish depend on certain minimum flows, others depend on fish





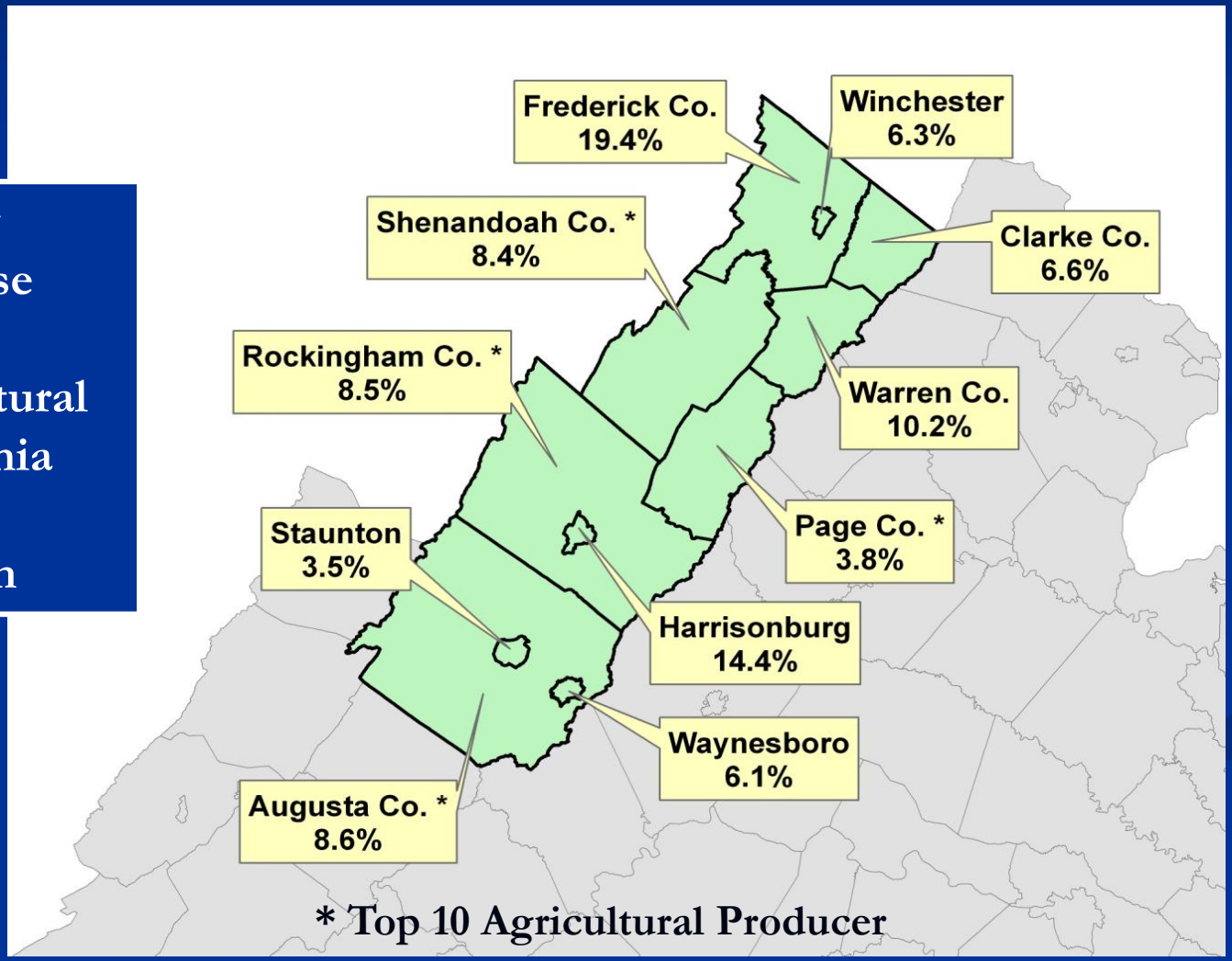
Why Important - Industry

Why Important - Residential

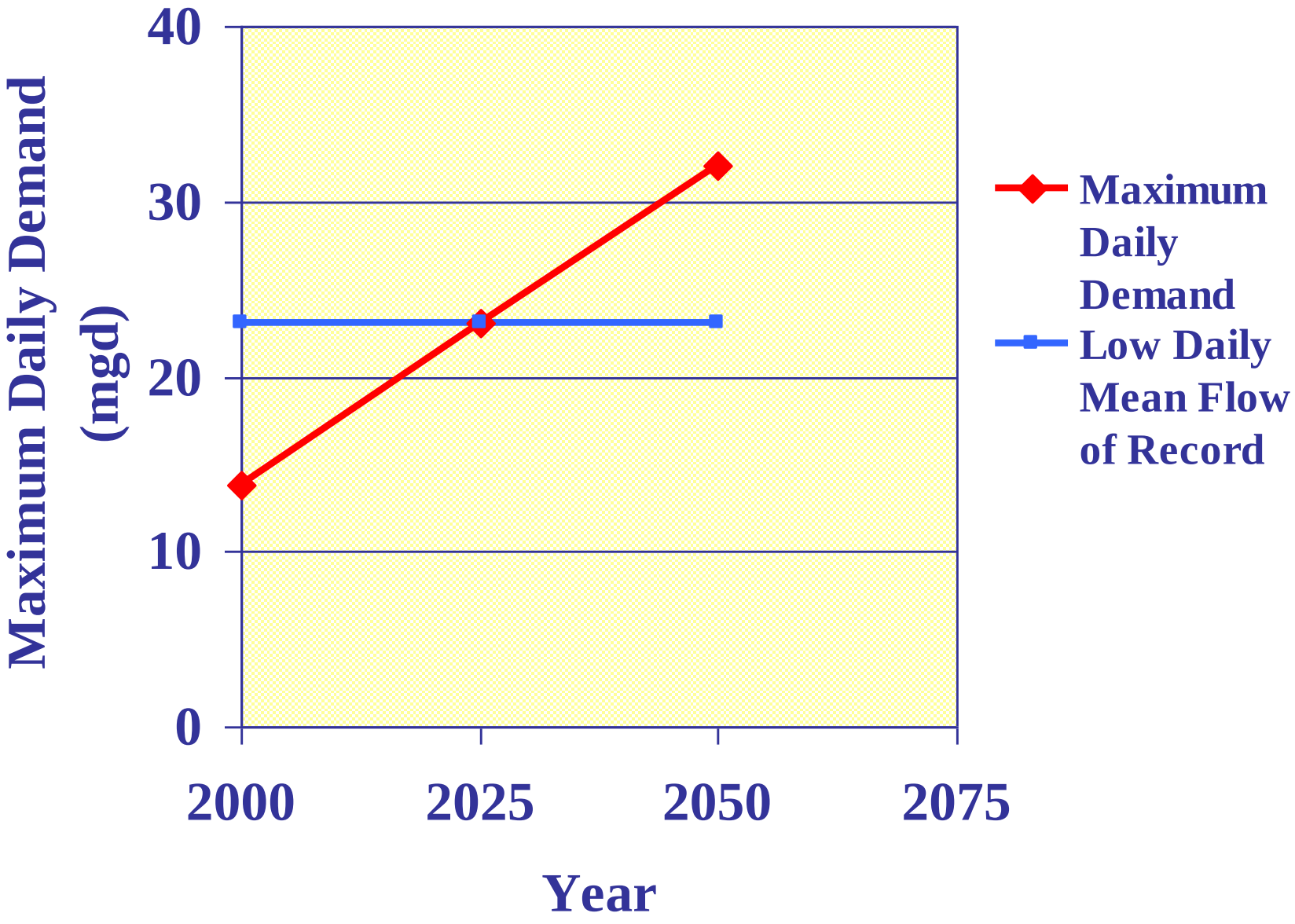


Why Concerned:
10 Year Population Projection

- ✓ Shenandoah Valley
  9% average increase
- ✓ 4 of top 10 Agricultural Producers in Virginia
- ✓ Water demand high



Supply and Demand in the North Fork

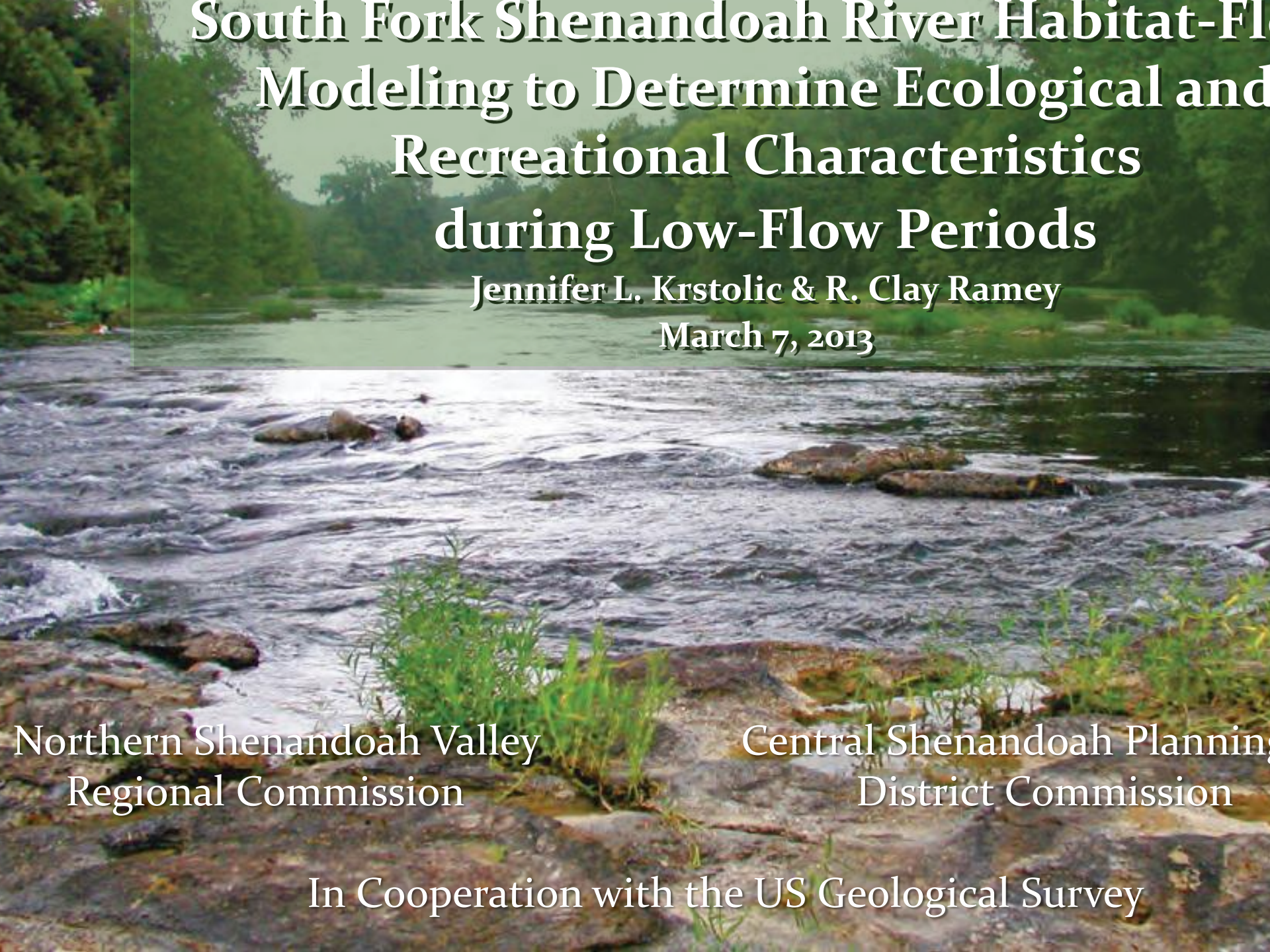


What are we doing: Water Supply Planning

- Commonwealth regulates water usage issues withdraw permits
- Major Drought 2002 triggered water supply plan requirements
- 30 year plans compiled to determine projected water consumption

What are we doing: Water Supply Planning

- Will there be enough water for all in 2040?
  - Business/Industry/Human consumption needs can be calculated/projected
  - Aquatic system needs protection
  - Angler/boaters/tourism harder to define water needs
- What minimum flow level sustains healthy river?
  - Economic/Social Impact
  - Human consumption limits based on scientific data



South Fork Shenandoah River Habitat-Fl
Modeling to Determine Ecological and Recreational Characteristics during Low-Flow Periods

Jennifer L. Krstolic & R. Clay Ramey

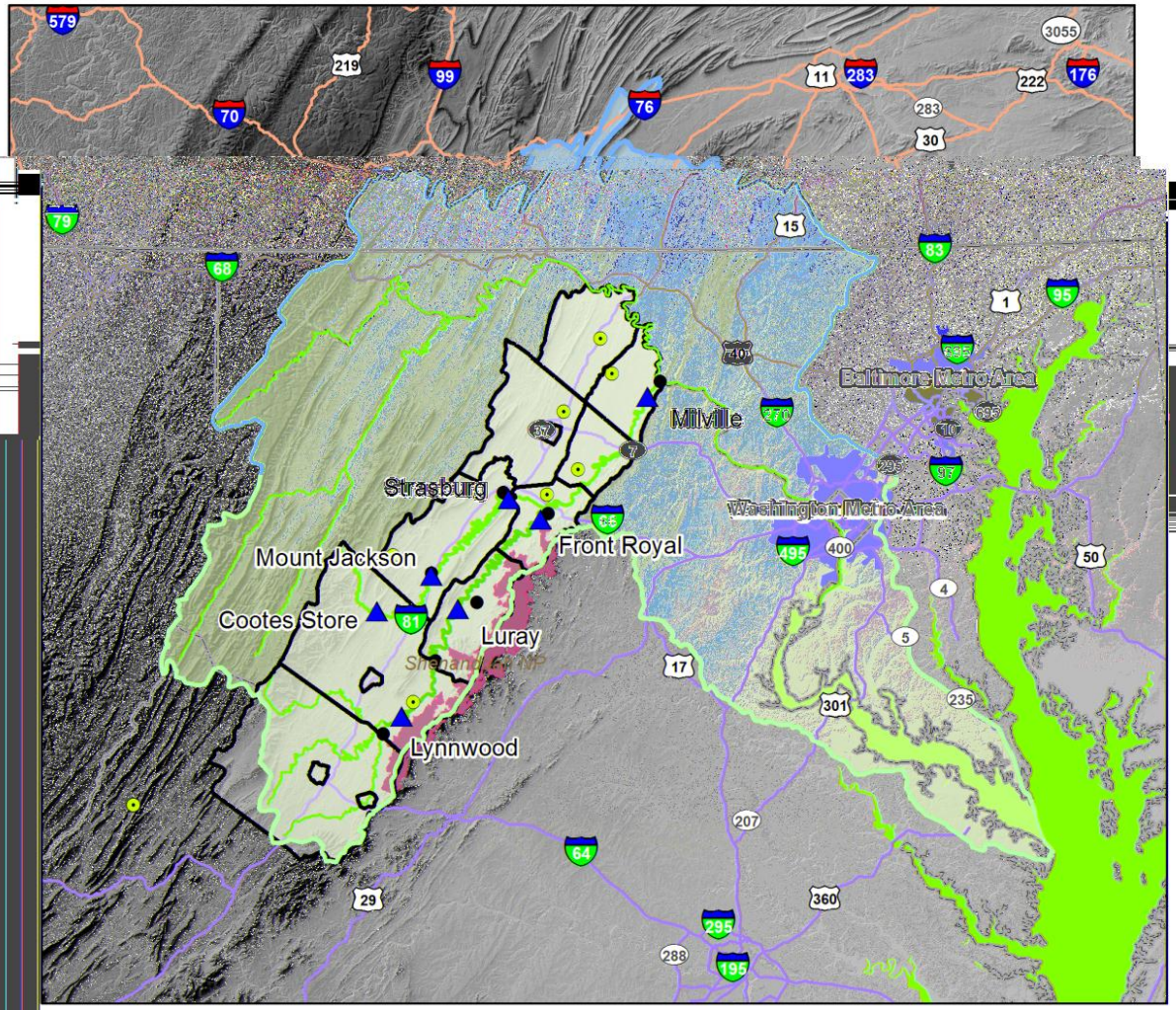
March 7, 2013

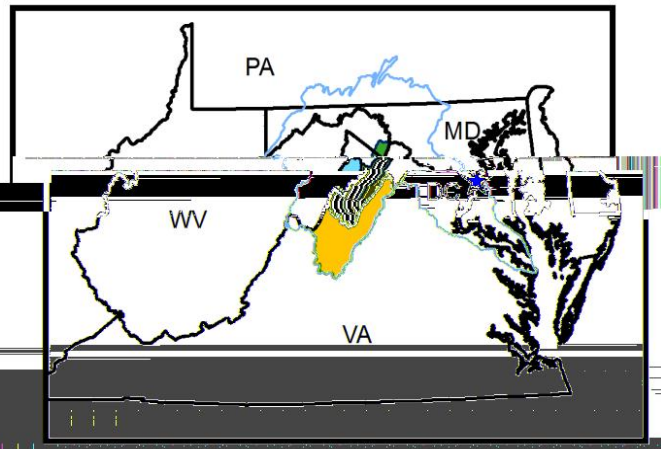
Northern Shenandoah Valley Regional Commission

Central Shenandoah Plannin District Commission

In Cooperation with the US Geological Survey

Geographic Setting of the Shenandoah River





Explanation

- Streamflow gaging station
- Shenandoah Valley Counties
- Real-Time Wells
- Major Rivers
- Potomac River Watershed

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USGS Long-Term Monitoring Provides Historic Flow Statistics

%	Front Royal 01631000	Luray 01629500	Lynnwood 01628500
	Discharge in Mgal/d		
	Annual		
95	3,005	2,702	2,023
90	2,042	1,790	1,357
75	1,138	976	724
50	613	535	390
25	344	304	218
10	249	228	152
5	212	198	128
7Q10	**160.0**	**145.0**	**97.0**
	July-August-September		
95	1,525	1,480	1,034
90	963	737	633
75	537	497	352
50	360	317	233
25	271	246	171
10	213	200	131
5	187	169	115

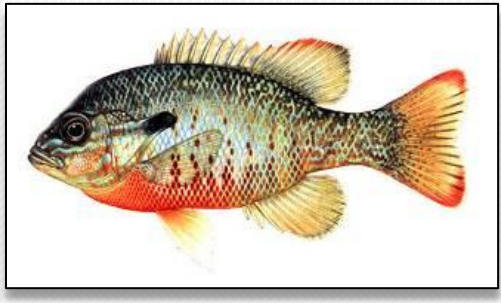
http://waterdata.usgs.gov/va/nwis/current/?type=flow&group_key=basin_cd

USGS science for a changing world

What are the Habitat Needs of Fish in the Shenandoah River Watershed?

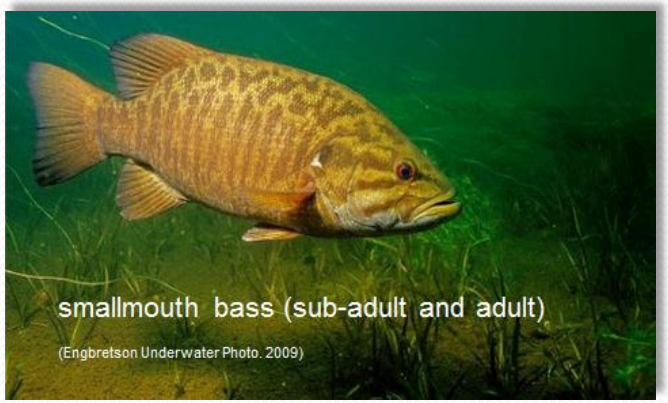
Non-game Fish

Game Fish



River chub
(www.fishbase.org)

Cyprinella spp.
(www.fishbase.org)


smallmouth bass (sub-adult and adult)
(Engbretson Underwater Photo. 2009)

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What are the Suitable Flow Ranges for Recreation in the Shenandoah River Watershed?

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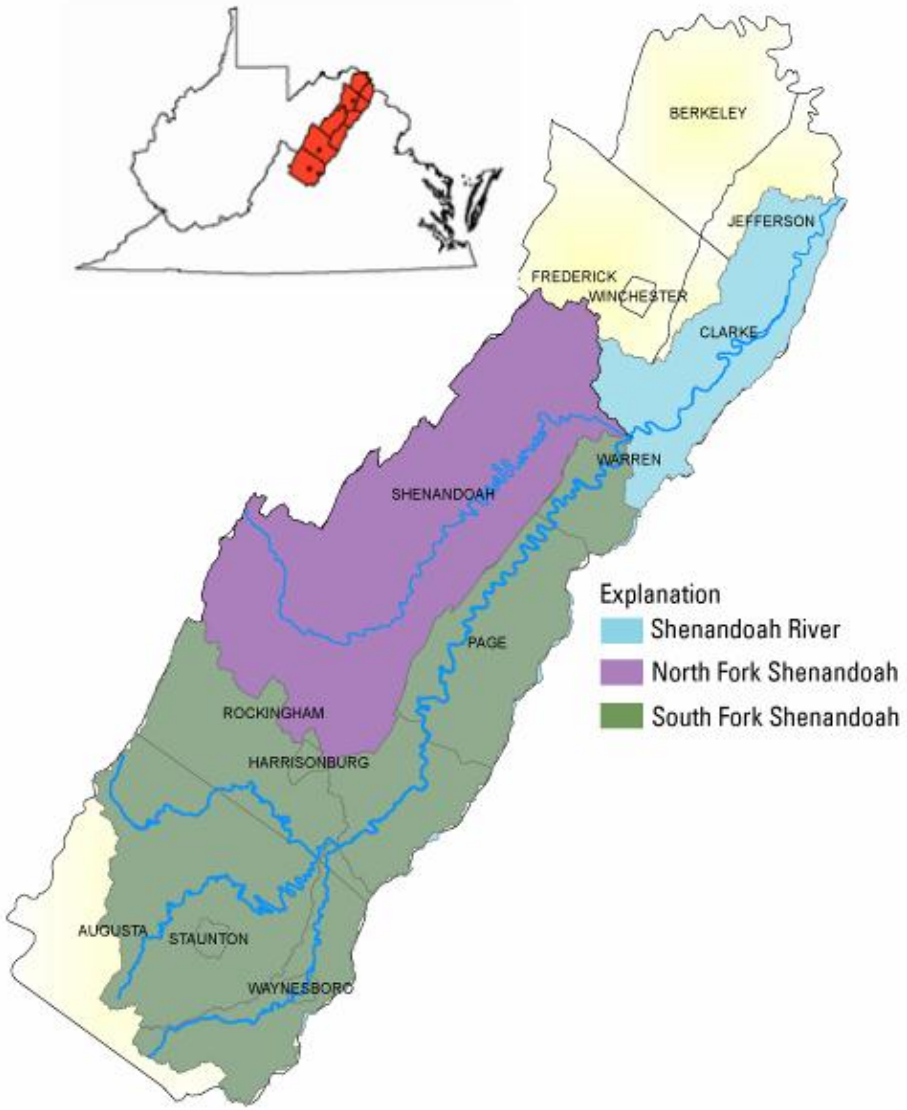
Benefits and Outcomes

- Field data collection coupled with habitat modeling to provide relevant recreation and ecological flow information for the Shenandoah River Watershed
- Select drought thresholds from science-based understanding of fish habitat needs.
- Update drought plans to include potential impacts on the aquatic community.
- Test state-mandated “Water Supply Planning Initiative” water-use scenarios for impacts to aquatic habitat.



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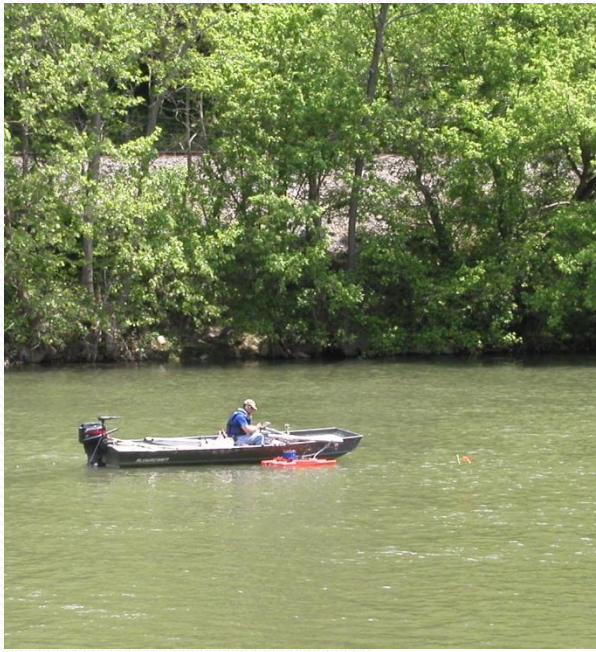
Shenandoah Watershed Field Approach

Field work at each study site:

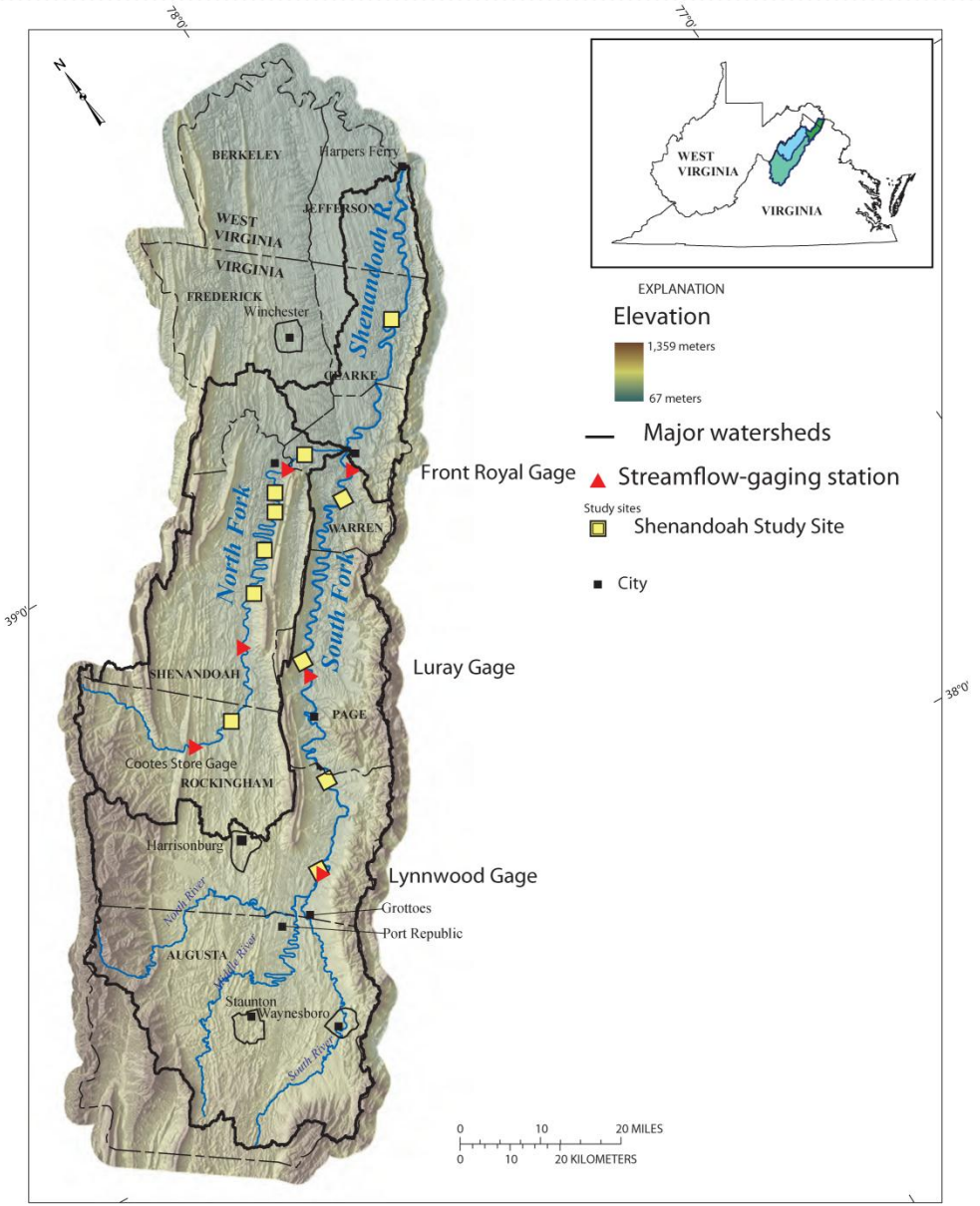
- GPS and surveying techniques
  - Elevation control for cross sections
  - Habitat mapping via canoe or boat
  - Survey water-surface slope

- Discharge and stage measured for a wide range of summer conditions
  - Acoustic Doppler Current meters used for velocity and discharge.



- Fish Community sampling and habitat
  - South Fork Shenandoah HSC by Ramey (2009), North Fork Shenandoah HSC by Persinger (2003)

Field: Study Site Design



Study Site and Model Grid

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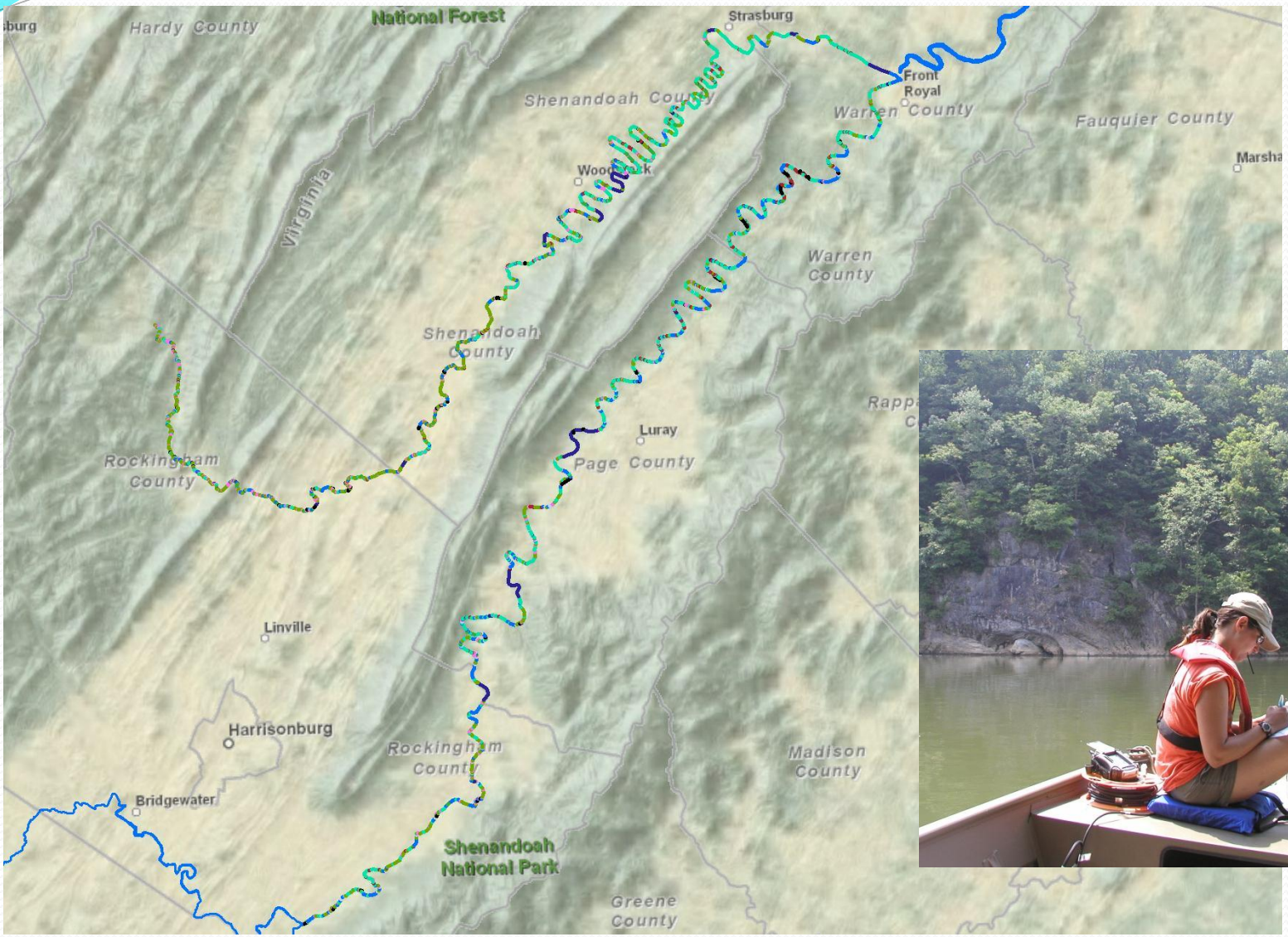
GPS Habitat Mapping by Boat



Riffle: 11.7 %
Run: 52.6 %
Pool: 35.7 %

HTTP://water.usgs.gov/GIS/metadata/usgswrd/XML/ds_539_Shenandoah_Habitat.xml

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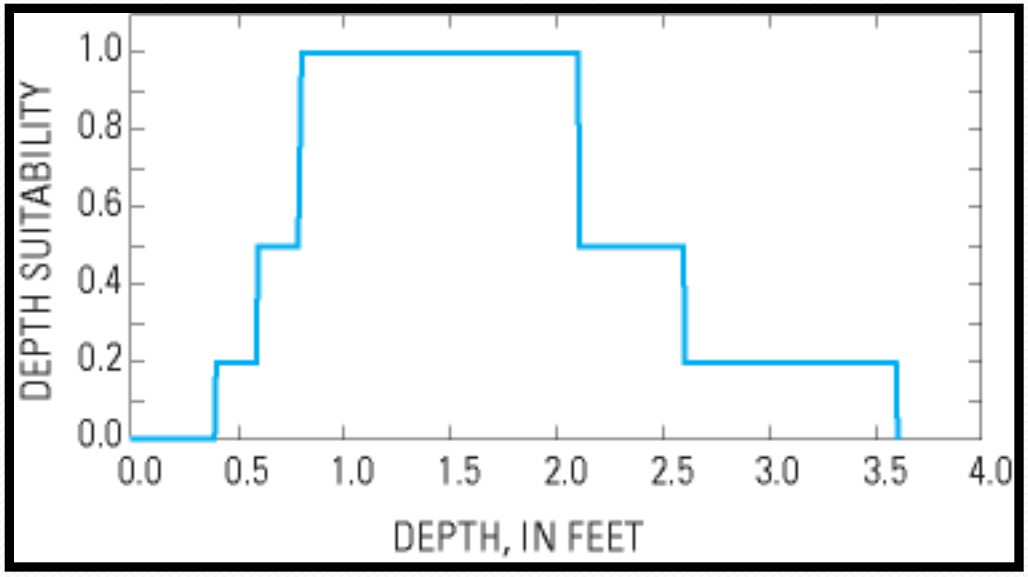
Fish Habitat-Suitability Curve Field Methods

- Snorkeling
- Electro-shocking
- Habitat Suitability Curves
  - Depth
  - Velocity
  - Substrate



VCU

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Fish Habitat Suitability Criteria: Depth

Depth Suitability Criteria for fish in the South Fork Shenandoah River					
		Suitable Range of Depths (ft)			
		Lower		Upper	
Taxa/Life Stage	n	Marginal	Optimal		Marginal
Sub-adult Smallmouth Bass	61	1.3	1.7	2.9	5.5
Smallmouth Bass	45	2.1	2.8	5.5	6.2
Juvenile Redbreast Sunfish	31	0.8	1.1	1.9	2.4
Sub-adult Redbreast Sunfish	31	1.3	1.8	3.6	4.4
Redbreast Sunfish	30	0.9	1.6	3.5	4.5
Cyprinella spp.	61	0.9	1.1	1.8	2.4
Margined Madtom	30	0.7	0.9	1.6	2.9
River Chub	54	0.1	1.1	2.1	2.9
Young of Year	37	0.9	1.1	2	3.7

HSC:
Depth
Velocity
Substrate

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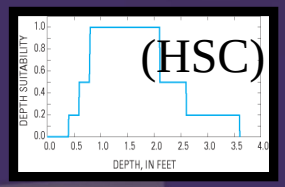
Model Development to Identify Ecological Flows

Fish Community Assessment

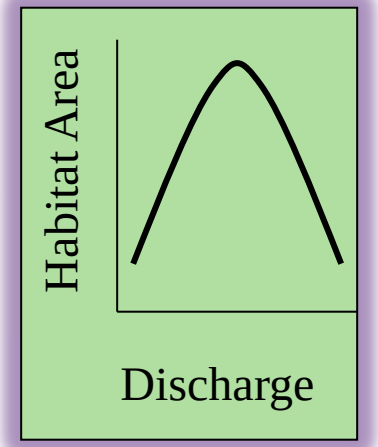


(HSC)

River-wide habitat Classification

RHABSIM

Habitat Simulation Model



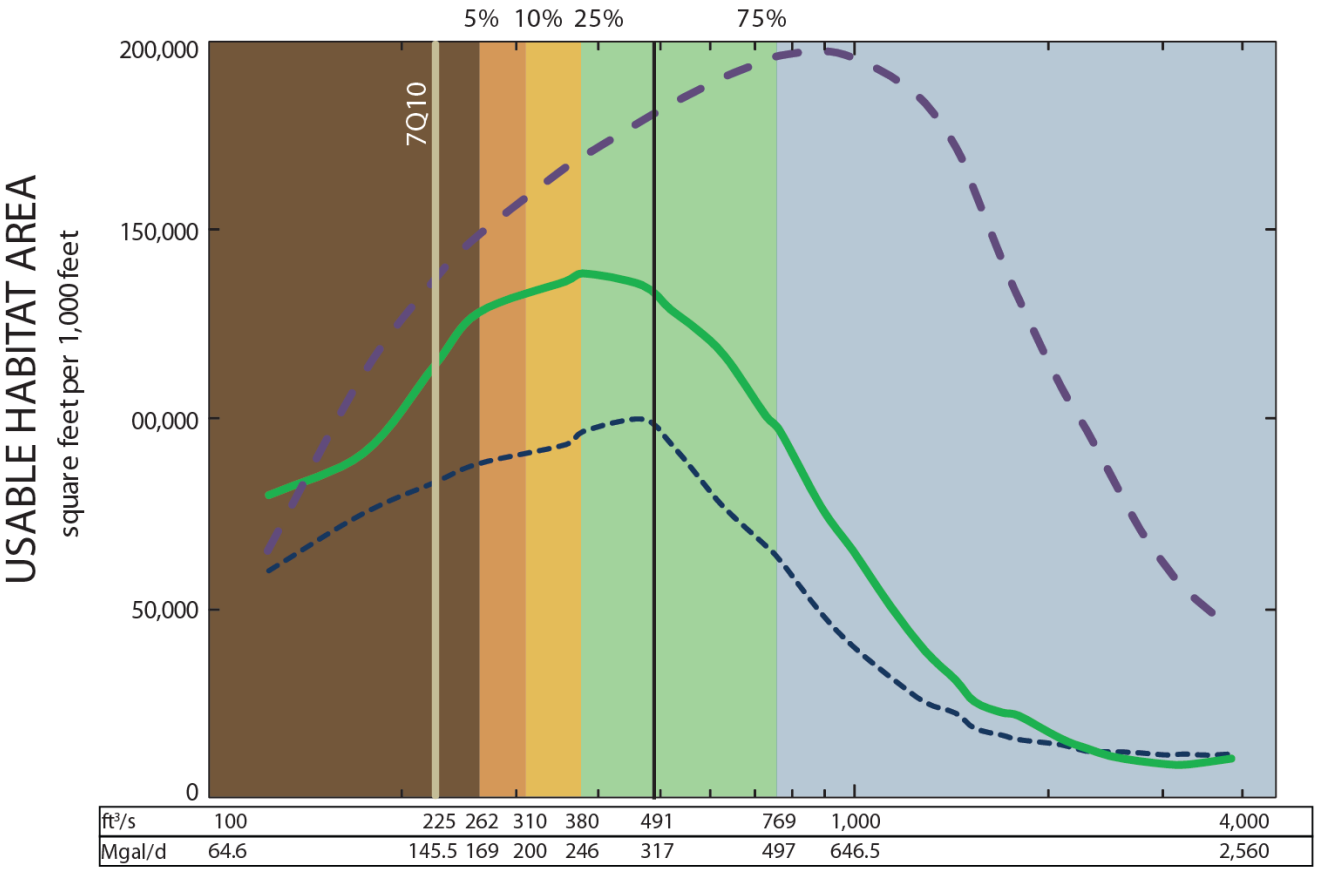
Historic Streamflow data

Calibration data: Discharge, Depth, Velocity

Manning's Equation:

$$V = \frac{1.486}{n} R^{2/3} S_e^{1/2}$$

Model output for Fish Habitat & Canoeing
Middle Section near Luray



Discharge in cubic feet per second (ft3/s) or million gallons per day (Mgal/d)

EXPLANATION

July–August–September flow percentiles

- >75%
- 25%–75%
- 10%–<25%
- 5%–<10%
- <5%

Ecological (fish) habitat

Game fish habitat

- Sub-adult smallmouth bass

Nongame fish habitat

- River chub

Recreational (canoe) habitat

- Canoeing

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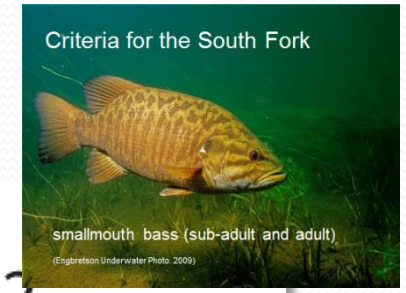
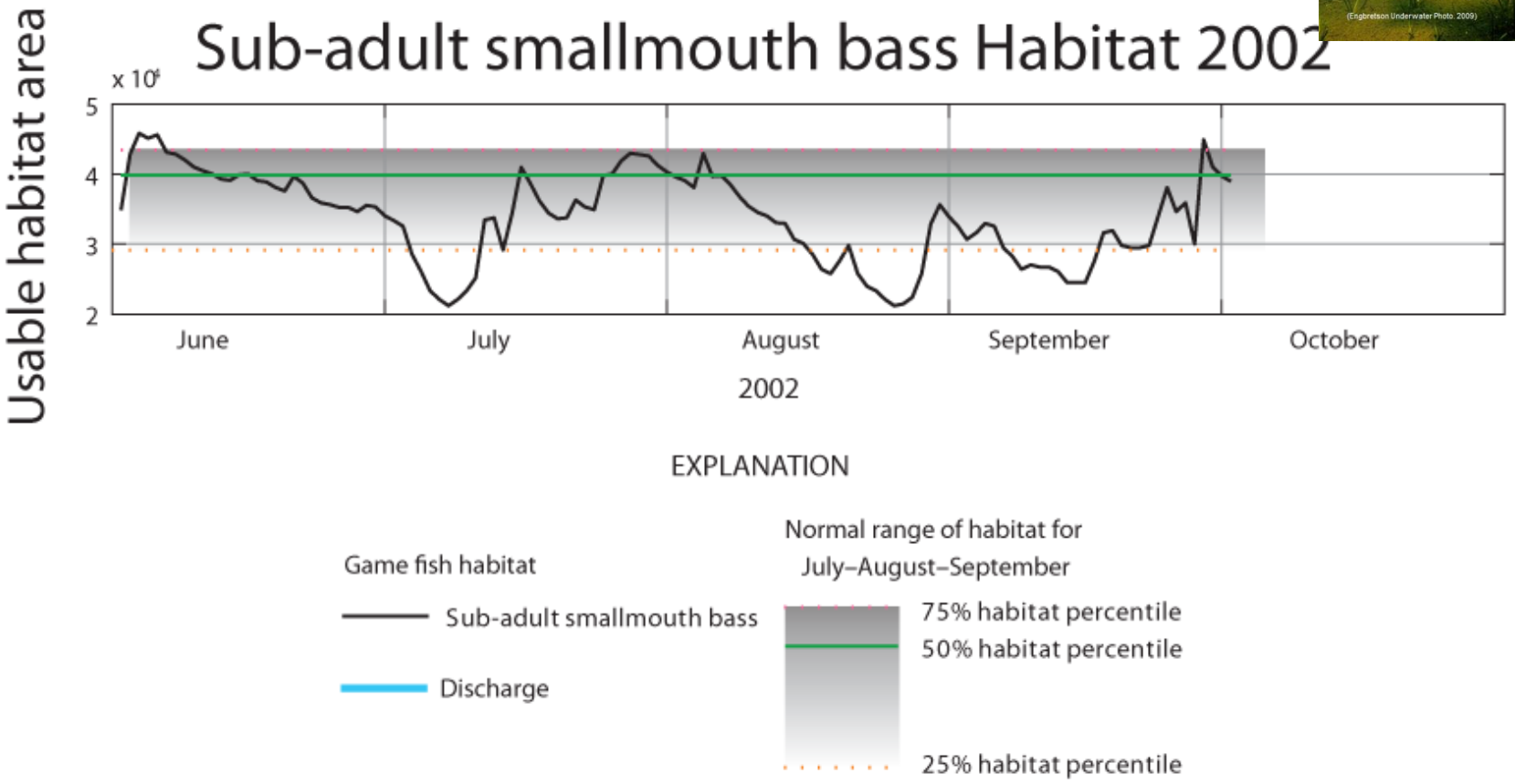
2002 Drought Habitat Assessment

Game Fish Habitat Availability during the Drought of 2002





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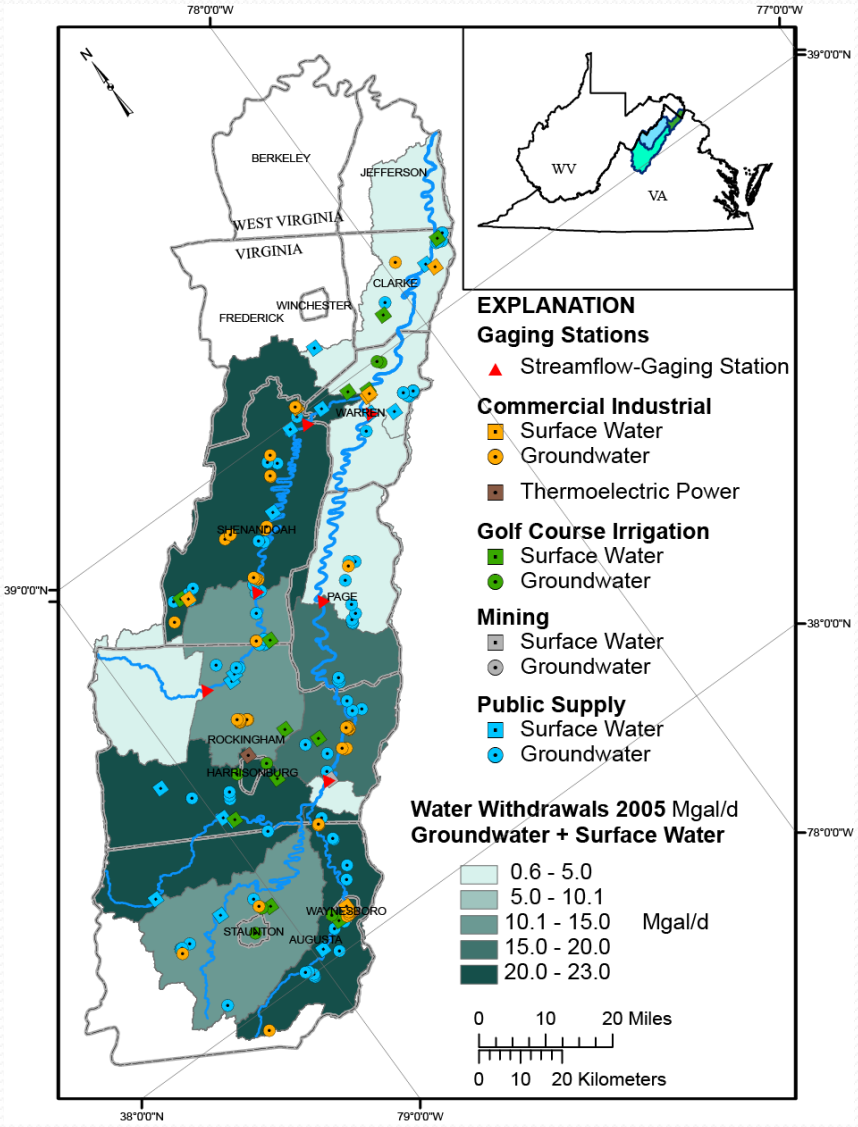
Water Withdrawals



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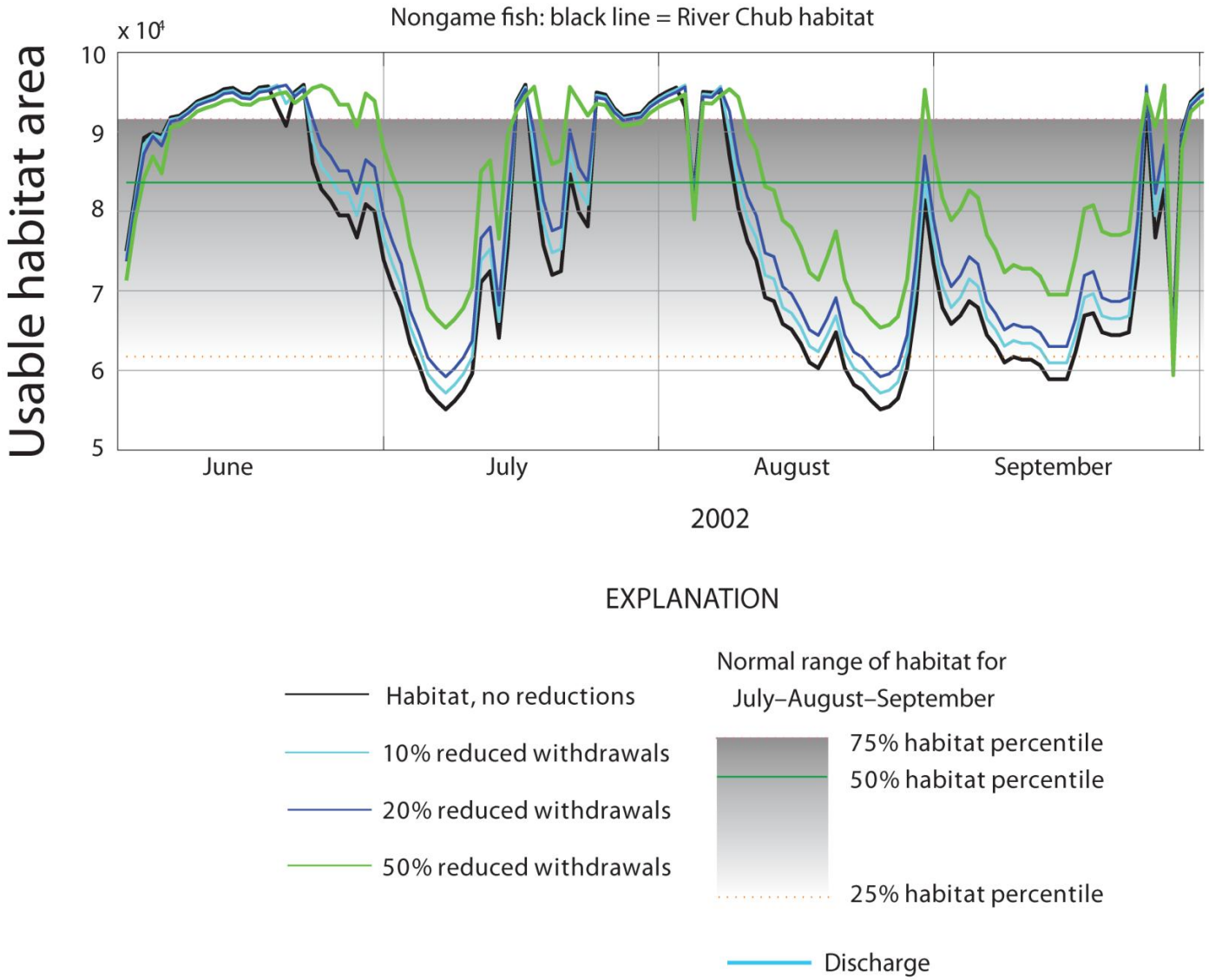
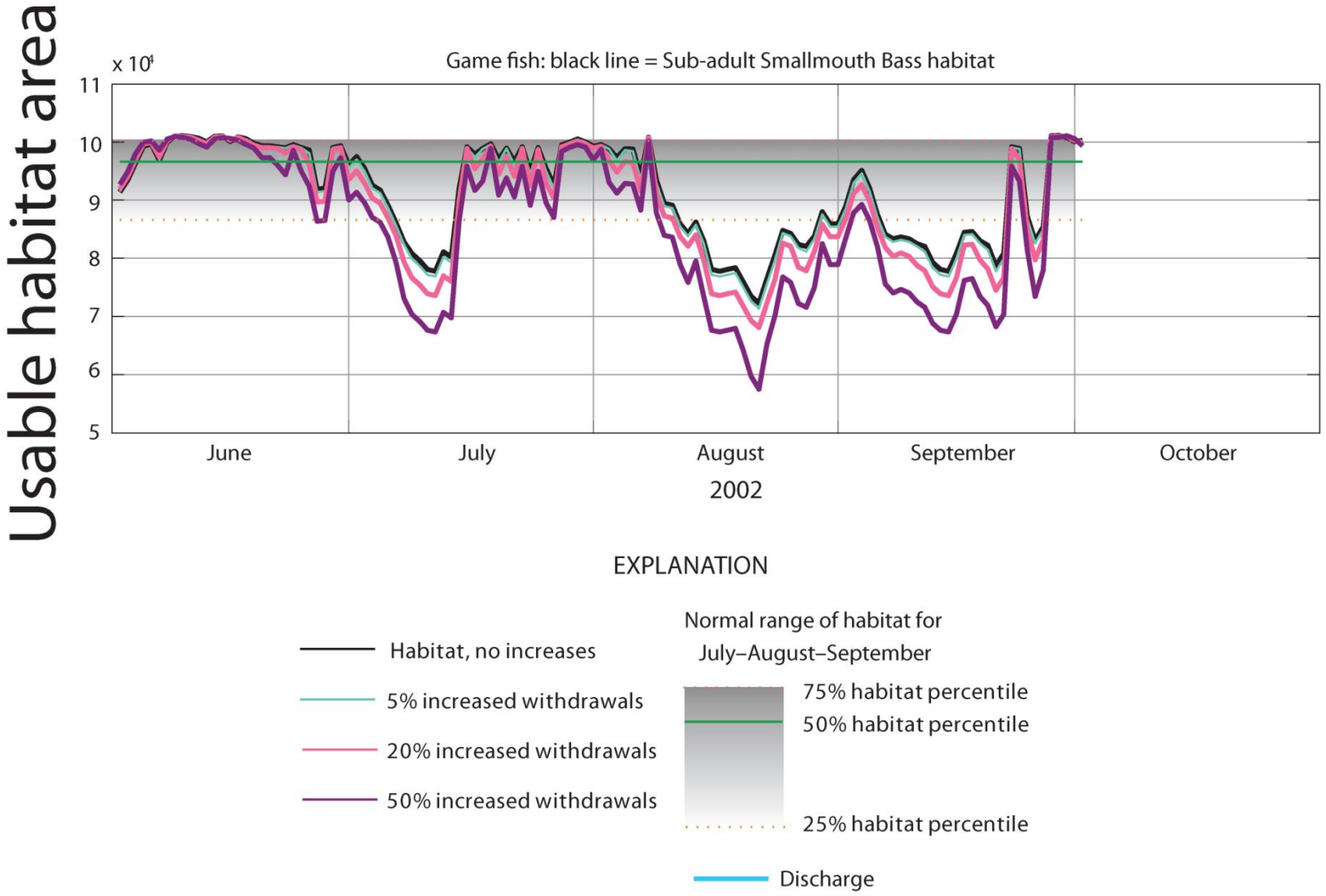
Conservation Scenarios:
10%
20%
50%
reduction in withdrawals

Water–Withdrawal Reduction Scenarios for the Middle Section



Increased Water-Use Scenarios:
5%
20%
50%

2002 Increased Water–Use Scenarios for the Middle Section



Findings

- Suitable recreation conditions occur when streamflows are greater than 50 percentile for summer.
- Habitat availability for fish is generally at a maximum when streamflows are between the 25th and 75th percentile
- A 'tipping point' below which habitat loss occurs in the lower part of the watershed was the 5% flow. For the upper portion of the watershed the tipping point was often 10% flow.
- Traditional flow statistics for drought planning (7Q10) are not protective of fish habitat.
- Timing of water withdrawals (or conservation) and preceding flow/habitat condition effects the magnitude of impact they have on habitat availability.
- During normal years, increased water use is not likely to correspond with habitat loss, but during drought years increased water use may cause extensive habitat loss.

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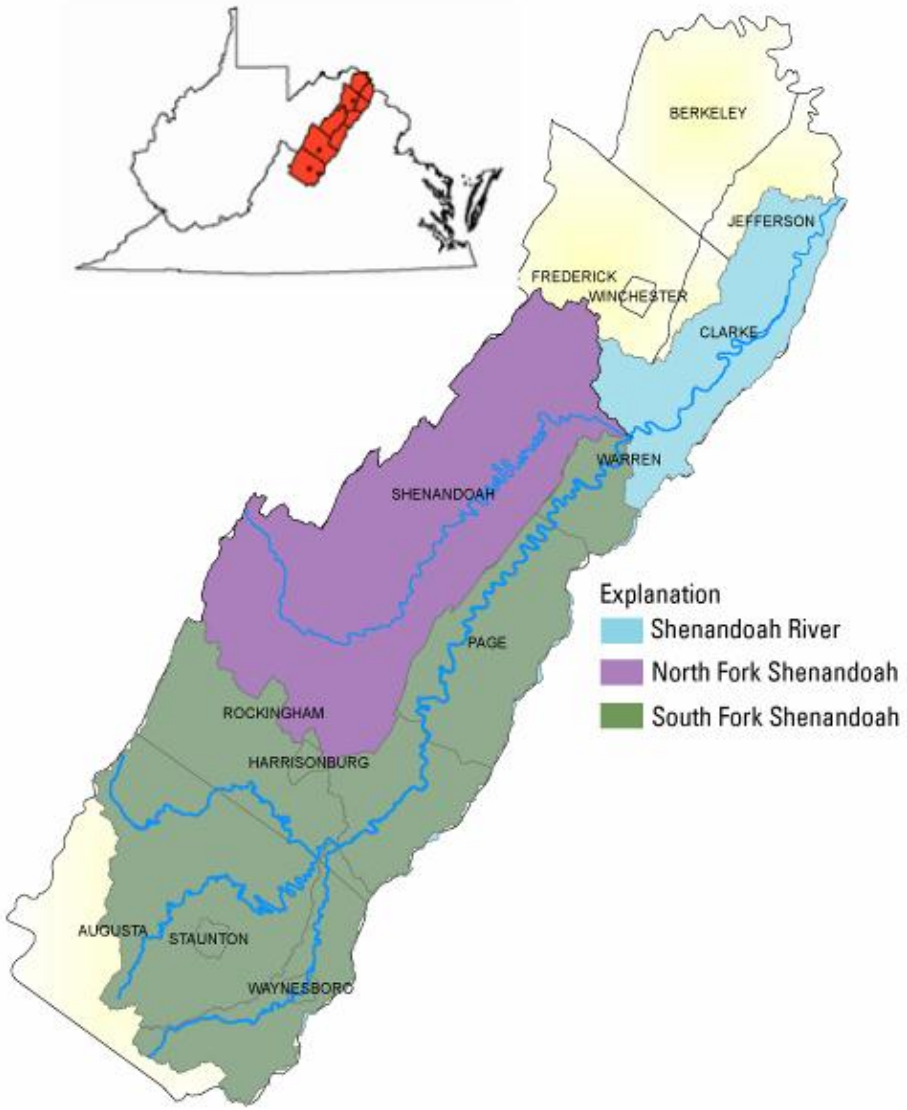
Benefits and Outcomes

- Field data collection coupled with habitat modeling to provide relevant recreation and ecological flow information for the Shenandoah River Watershed
- Select drought thresholds from science-based understanding of fish habitat needs.
- Update drought plans to include potential impacts on the aquatic community.
- Test state-mandated “Water Supply Planning Initiative” water-use scenarios for impacts to aquatic habitat.



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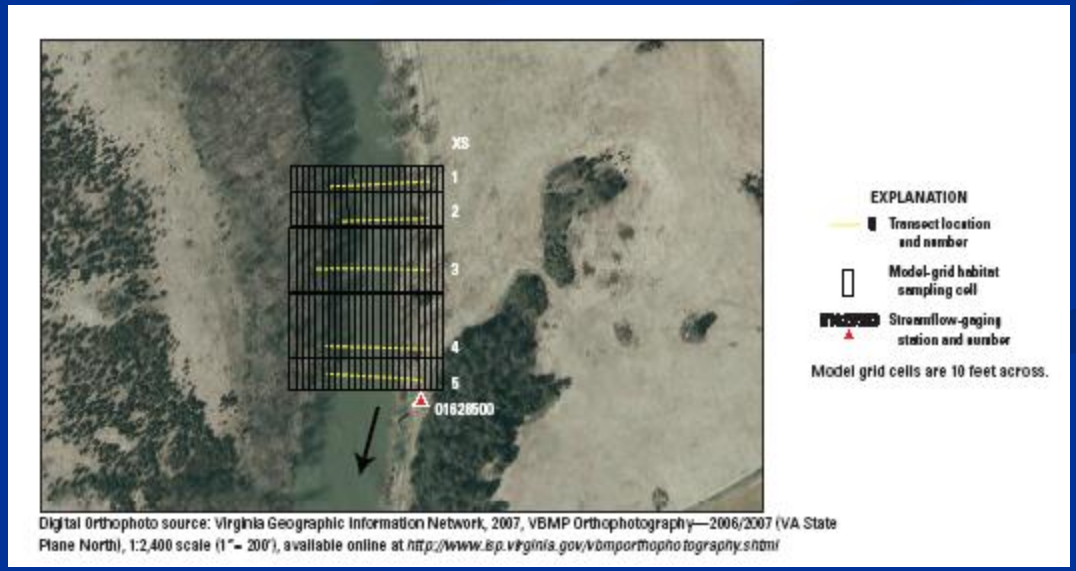
Environmental Flows

Alison Teetor

Natural Resource Planner

What are we doing:
Uses of Minimum Instream Flow Data

- Local - Drought Response (current)
- State - Water withdrawal permitting (future)
- Regional - Offsite storage needs (future)

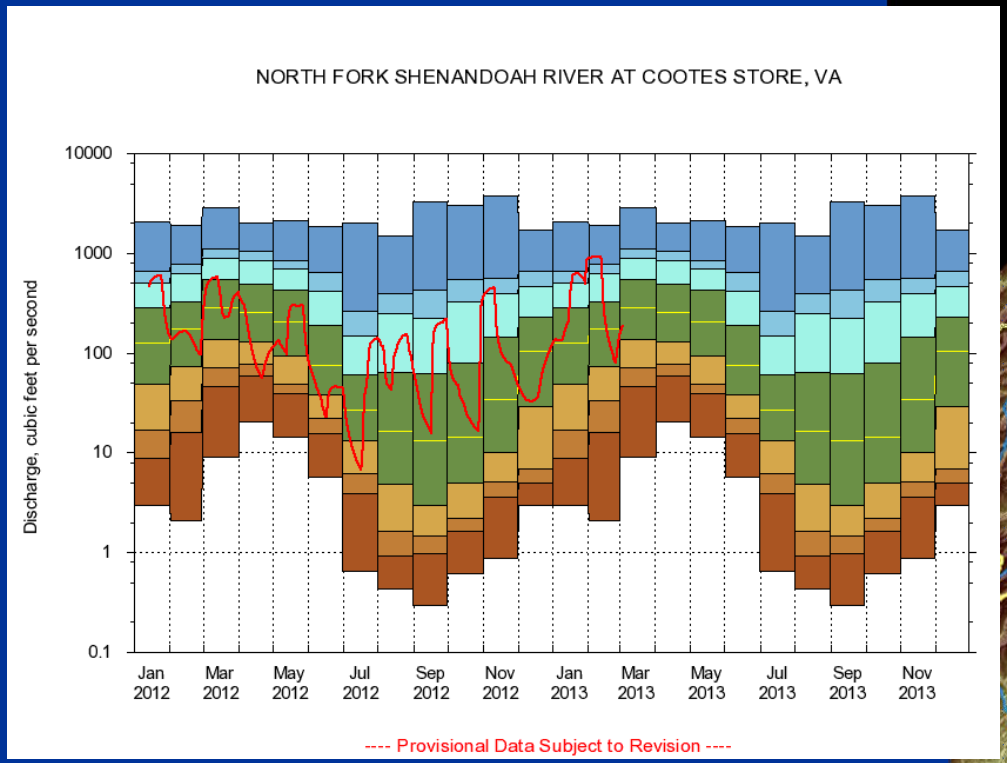


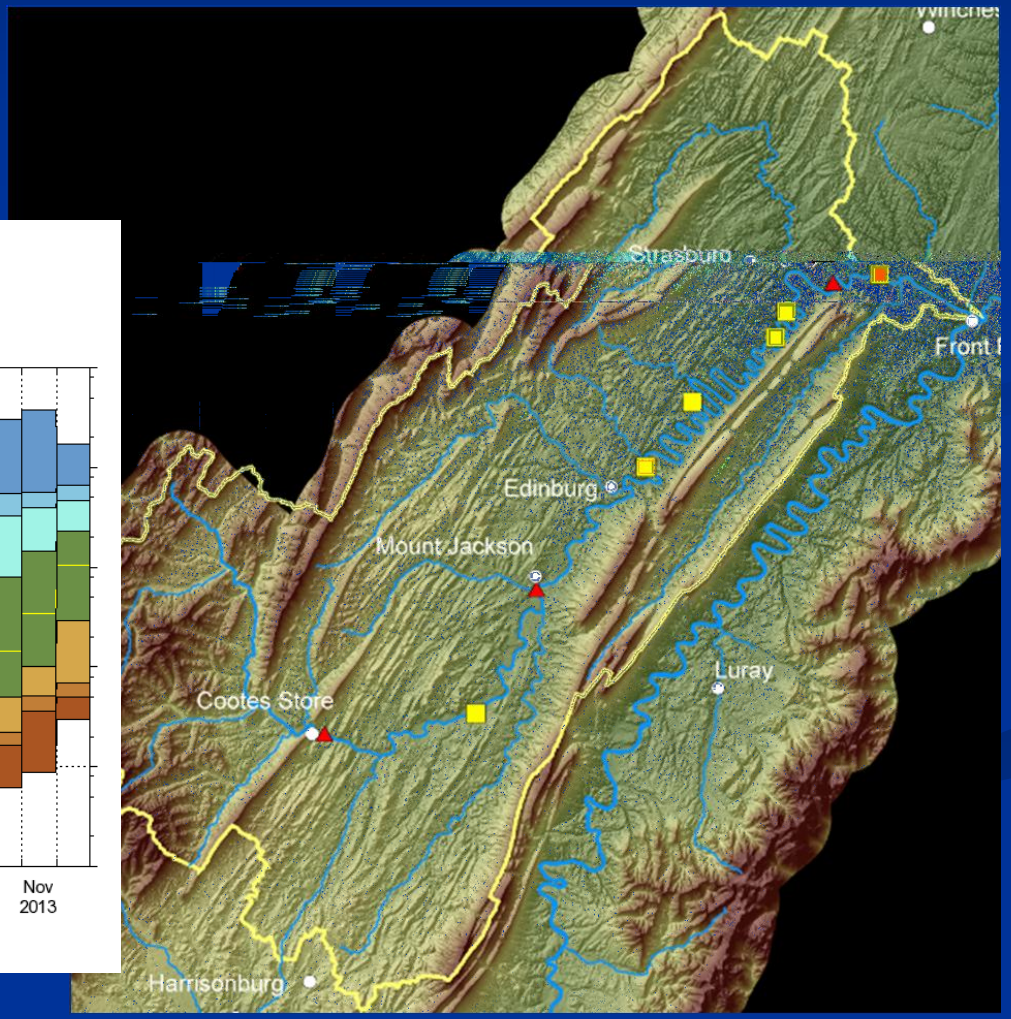
What are we doing: Drought Response Plan

- Drought Indicators
  - **Precipitation**
  - **Stream flow**
  - **Groundwater levels**
  - **Palmer Drought Severity Index (PDSI)**

What are we doing: Drought Response

- Incorporate low flow data in Drought Response





What are we doing: Drought Response Plan

Stage levels

Stage	Cootes Store	Mt. Jackson	Strasburg
Normal	62% (>100 cfs)	37% (>120 cfs)	22% (>150cfs)
Watch	62% (< 100 cfs)	37% (>120 cfs)	22% (>150 cfs)
Warning	50% (<60 cfs)	25% (<75 cfs)	5 % (<90 cfs)
Emergency	33% (<25 cfs)	4 % (<30 cfs)	1 % (<65 cfs)

South Fork Shenandoah Front Royal	
Normal	> 25%
Watch	25%
Warning	10%
Emergency	5%

What are we doing: Drought Response Plan

Watch

- Precipitation at or below normal for time period
- Stream Flow 10-25%
- Groundwater 10-25%

Warning

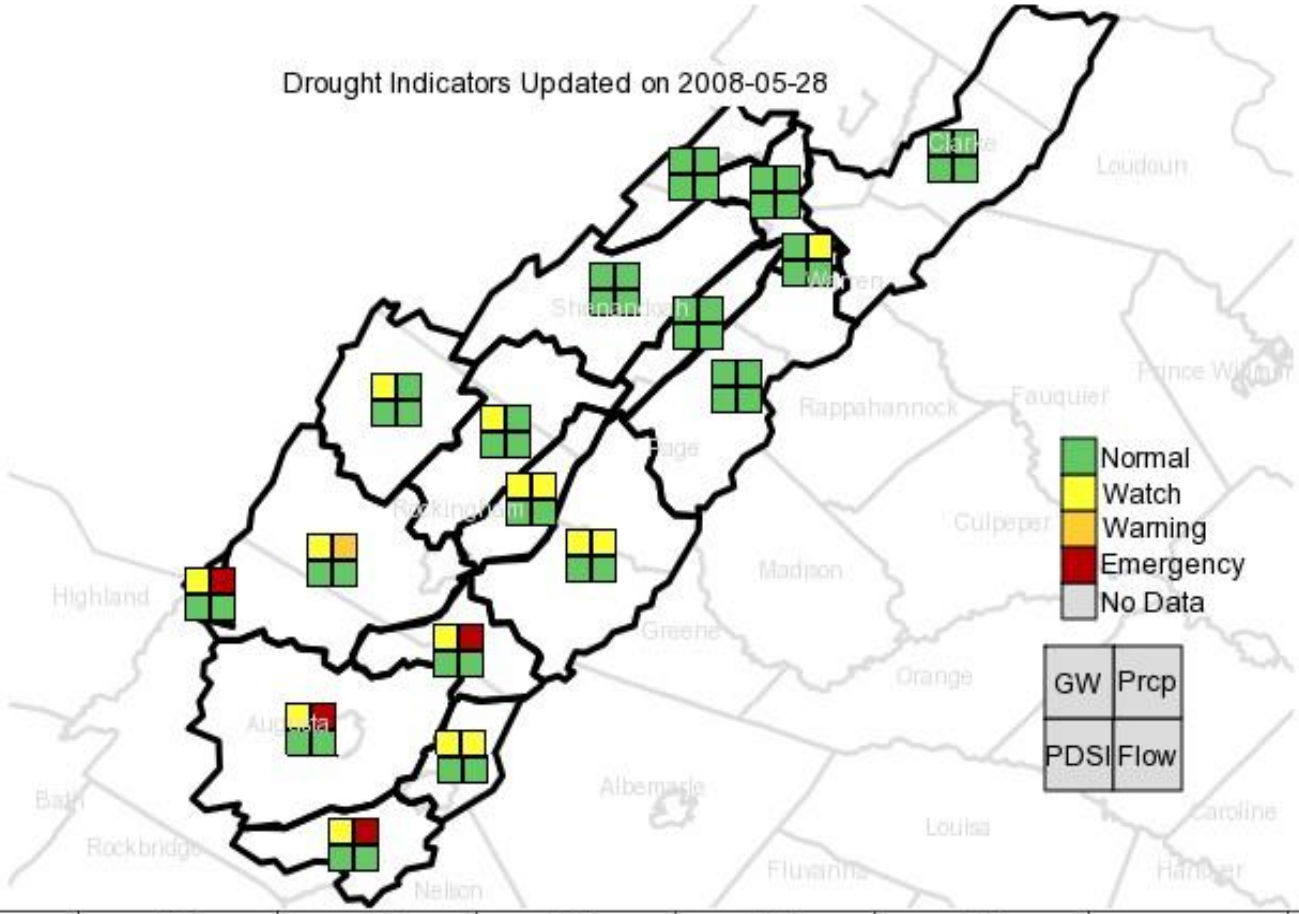
- Precipitation at or below normal for time period
- Stream Flow below 10%
- Groundwater below 10%

Emergency

- Precipitation at or below normal for time period
- Stream Flow at or below 5%
- Groundwater at or below 5%

Stage Declaration

Web Site Development Drought Awareness

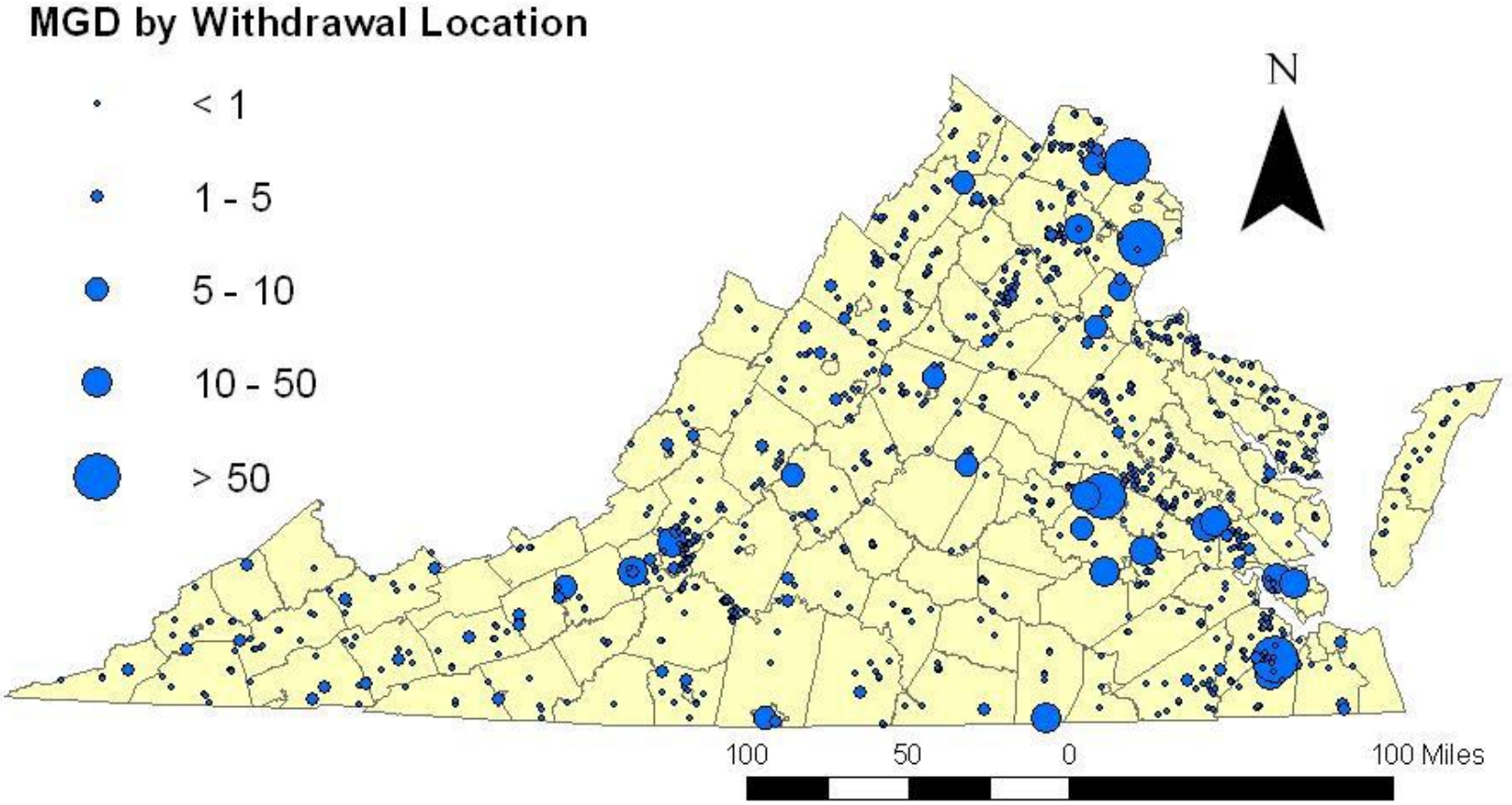


	D4 Exceptional	D3 Extreme	D2 Severe	D1 Moderate	D0 Abnormally Dry	Normal	Wet
Drought Intensity							

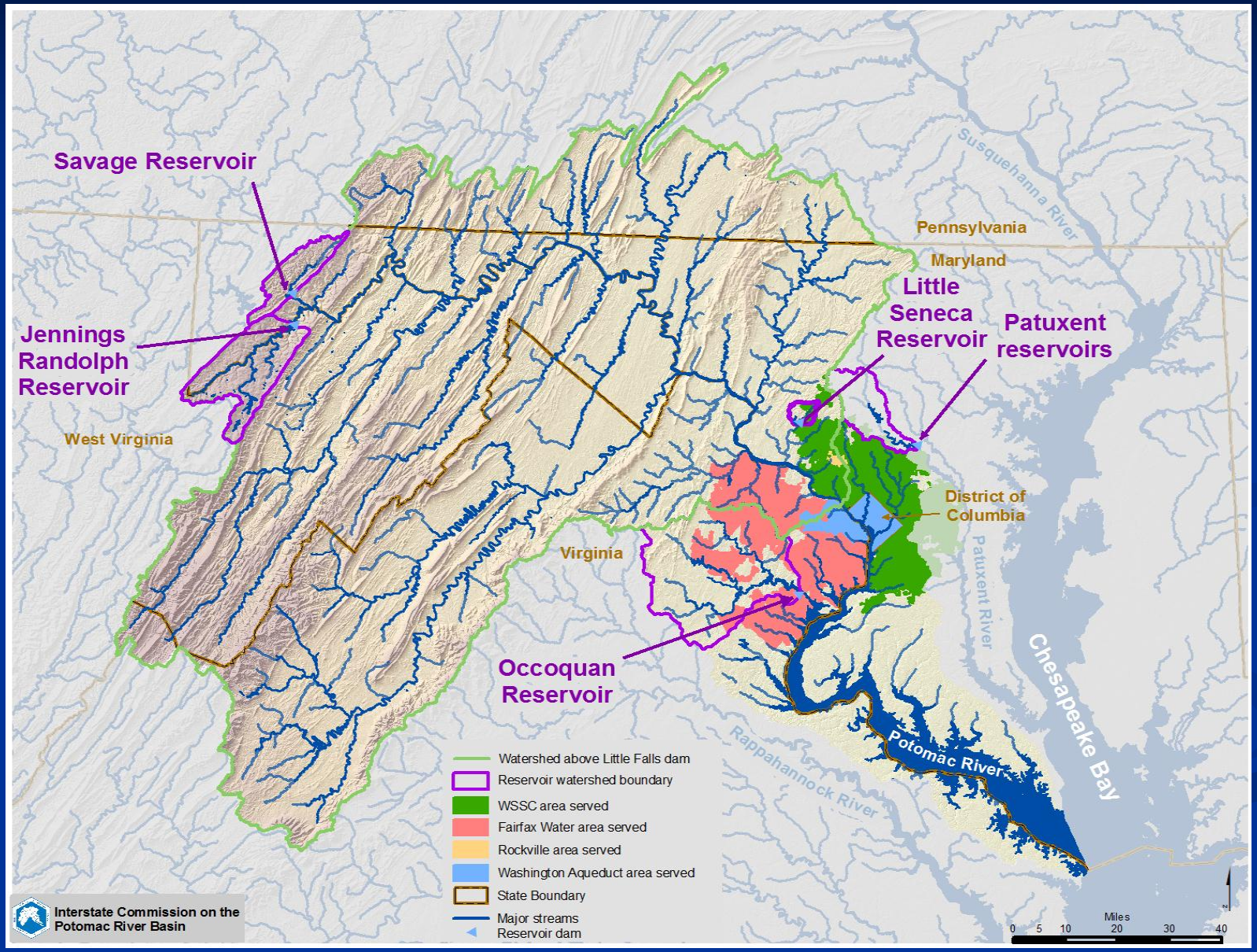
What are we doing: Regional Investment

- Long term regional approach
- 2 Planning Districts, 7 Counties, 4 Cities, numerous towns have all worked together
- 20 years and still going strong USGS partnership
- Long term monitoring data essential
- Stream gage data vitally important

State Water Withdrawal Permitting



Offsite Storage



Speaker Contacts and Resources

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http://www.clarkecounty.gov/

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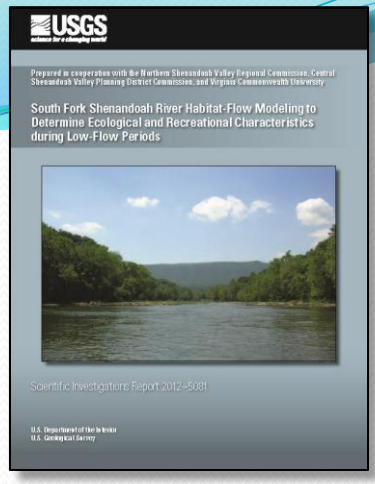
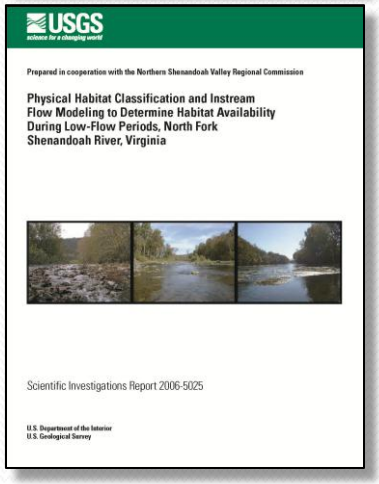
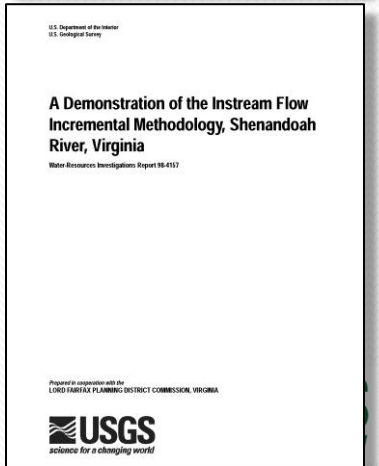
Jennifer Krstolic, Biogeographer

(804) 261-2635 jkrstoli@usgs.gov

http://va.water.usgs.gov/

<u>Publications:</u>

http://pubs.usgs.gov/sir/2012/5081/

http://pubs.usgs.gov/sir/2006/5025/

http://pubs.er.usgs.gov/publication/wri984157