

Environmental Issues



Photo courtesy of J. Willoughby, 2005, ICPRB

West Virginia Water Resources Training Workshops

Presented by the Interstate Commission on the
Potomac River Basin

Sponsored by the West Virginia Department of
Environmental Protection

With funding from the American Reinvestment
& Recovery Act





Introduction

- Environmental Flows
 - Definition
 - Concepts
 - Tools
- Water Quality
 - Clean Water Act
 - Impairments
 - Total Maximum Daily Loads (TMDLs)



Environmental flows



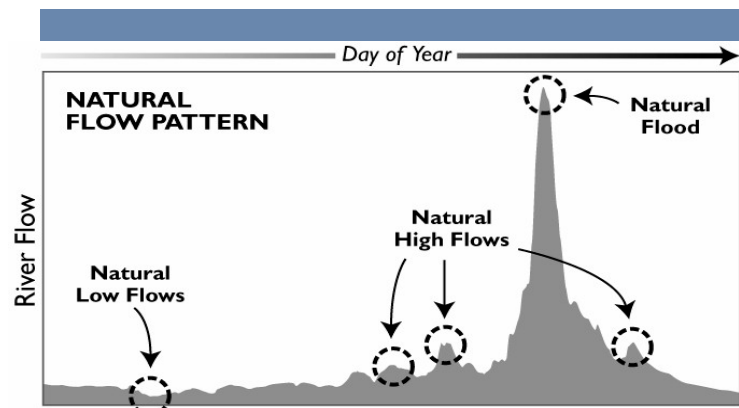
Photo courtesy of
J. Willoughby, ICPRB

Environmental flows can be defined as the quality, quantity and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems that provide multiple goods and services to people.

(Cummins et al., 2010)

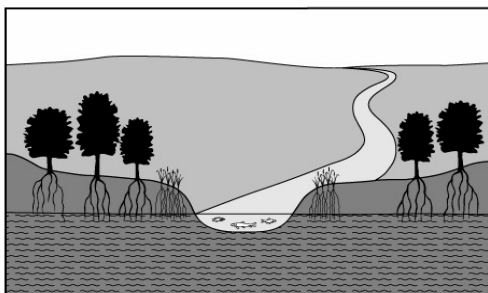


Environmental flows (cont'd)



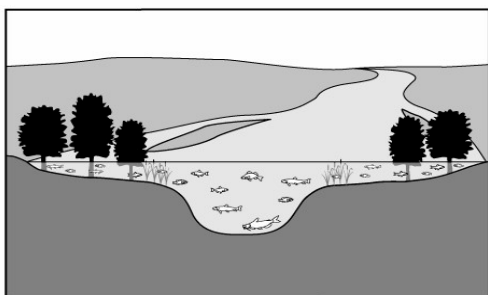
Natural Low Flow

- Fish have adequate oxygen and can move up- or downstream to feed
- Riparian vegetation sustained by shallow ground water table
- Insects feed on organic material carried downstream
- Birds supported by healthy riparian vegetation and aquatic prey



Natural Flood

- Fish are able to feed and spawn in floodplain areas
- Riparian plant seeds germinate on flood-deposited sediments
- Insects emerge from water to complete their lifecycle
- Wading birds and waterfowl feed on fish and plants in shallow flooded areas

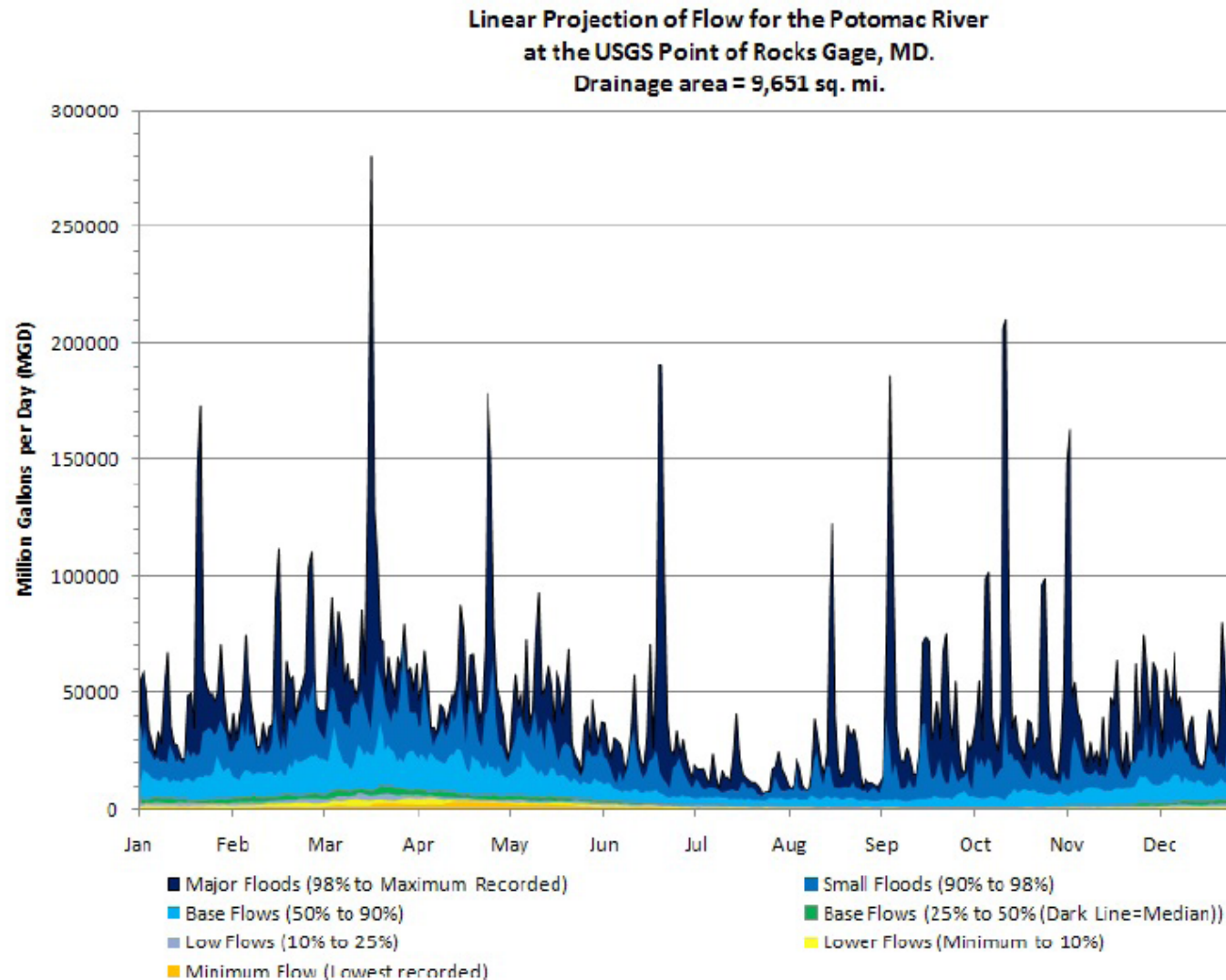


- Ecological integrity depends on maintaining quantity of flows and flow variability
 - Need right amount of water at right time
 - High/low flow indicators such as:
 - 7Q10: the lowest stream flow for seven consecutive days that would be expected to occur once in ten years
 - Influences: impoundments, withdrawals...



Figure: (Richter, 2004)

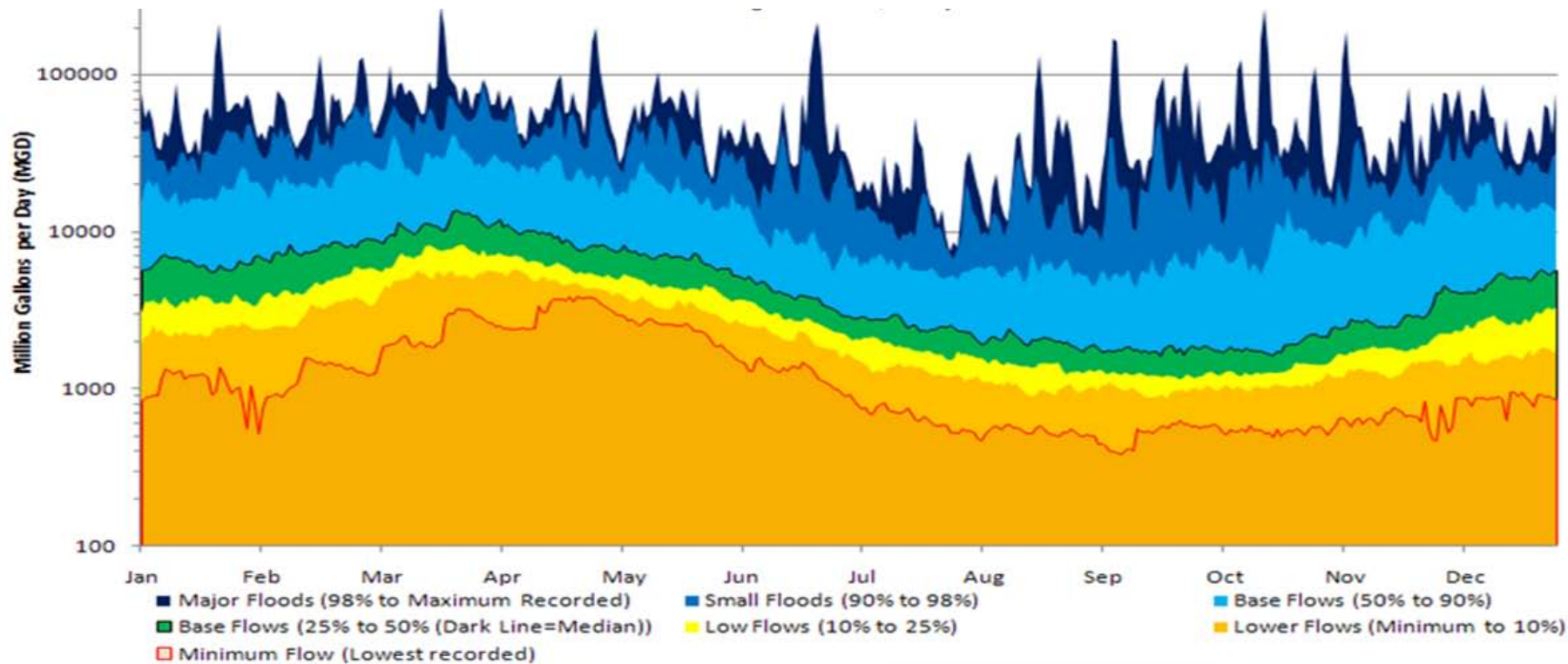
Environmental flows (cont'd)



(Cummins et al., 2010)



Environmental flows (cont'd)



ATLANTIC STURGEON

Migration into tidal headwaters
Adult Spawning

Egg and larval
development

Juvenile Growth in tidal freshwater

Emigration to ocean

SHORTNOSE STURGEON

Juvenile
growth

Migration into tidal headwaters
Adult spawning

Egg and
larval
development

Juvenile Growth in tidal freshwater

AMERICAN EEL

Juvenile (elver) in
migration into estuaries

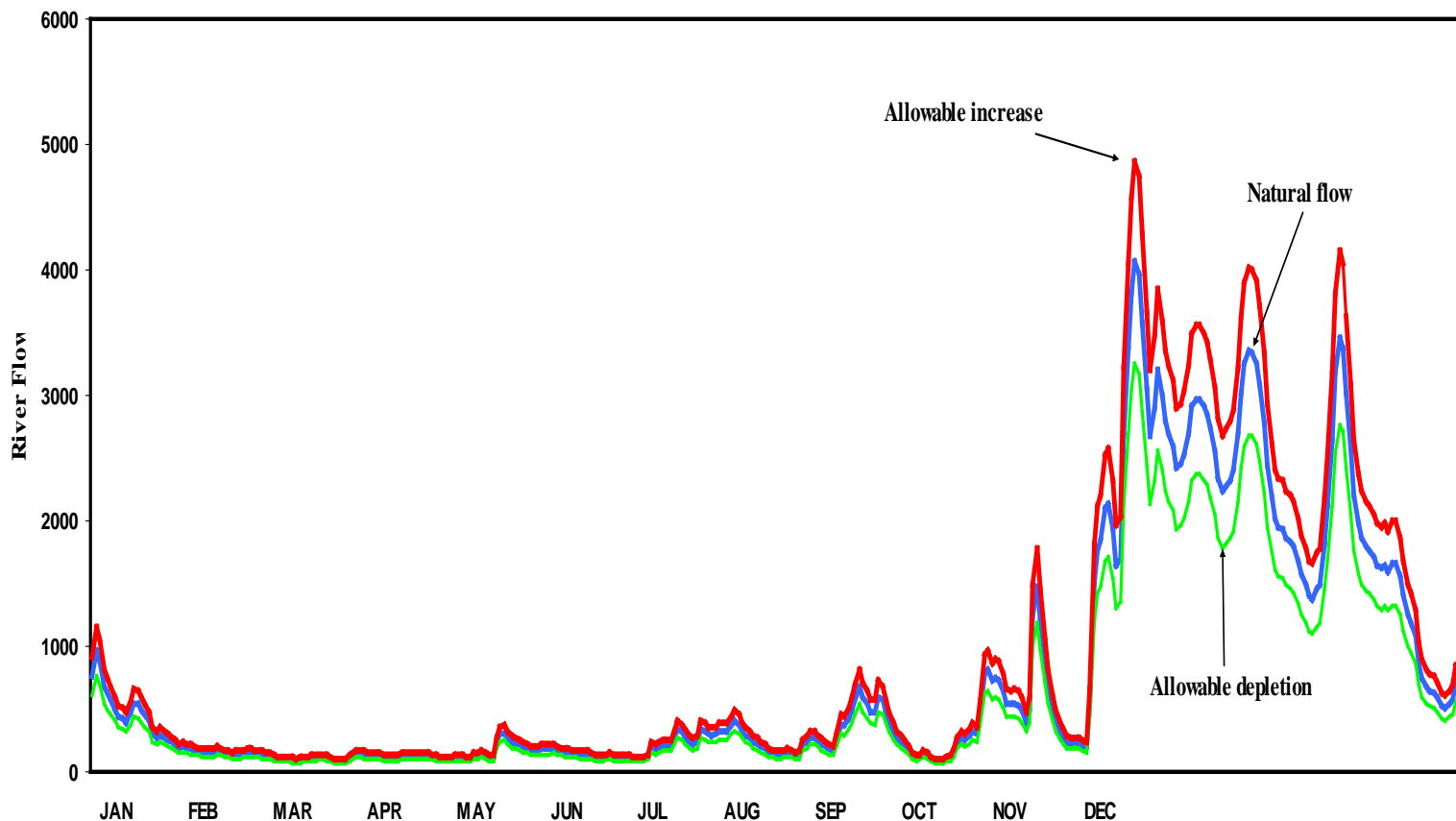
Juvenile and Adult Growth occurs in tributaries
and headwater streams

Adult (yellow eel) emigration
High flows cue outmigration

(Cummins et al., 2010)

Environmental flows (cont'd)

Percent of Flow Approach





(Richter, 2004)




Environmental flows (cont'd)


West Virginia Water Withdrawal Guidance Tool (www.dep.wv.gov)

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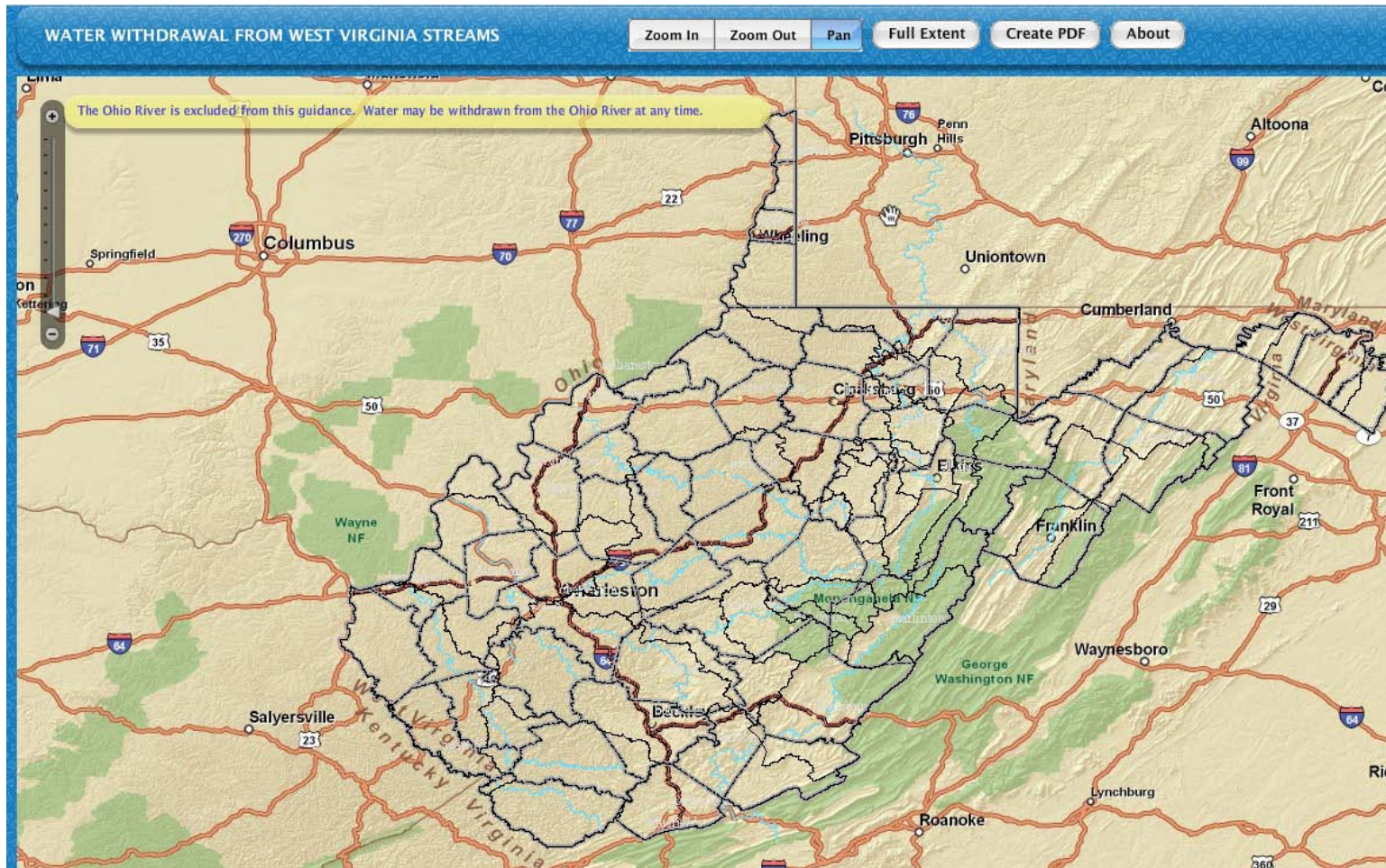
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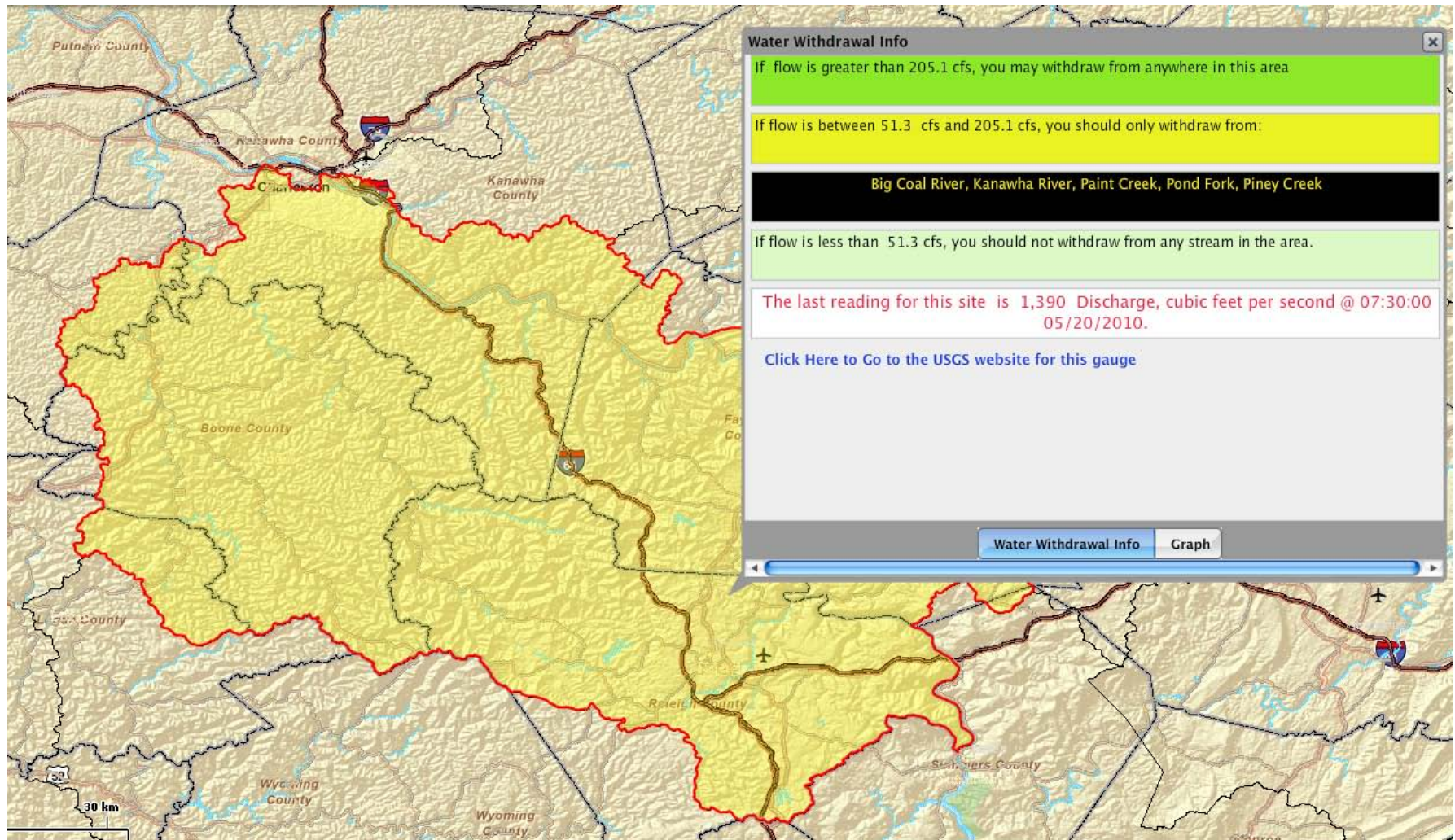
Environmental flows (cont'd)

West Virginia Water Withdrawal Guidance Tool



Environmental flows (cont'd)

West Virginia Water Withdrawal Guidance Tool





Environmental flows (cont'd)

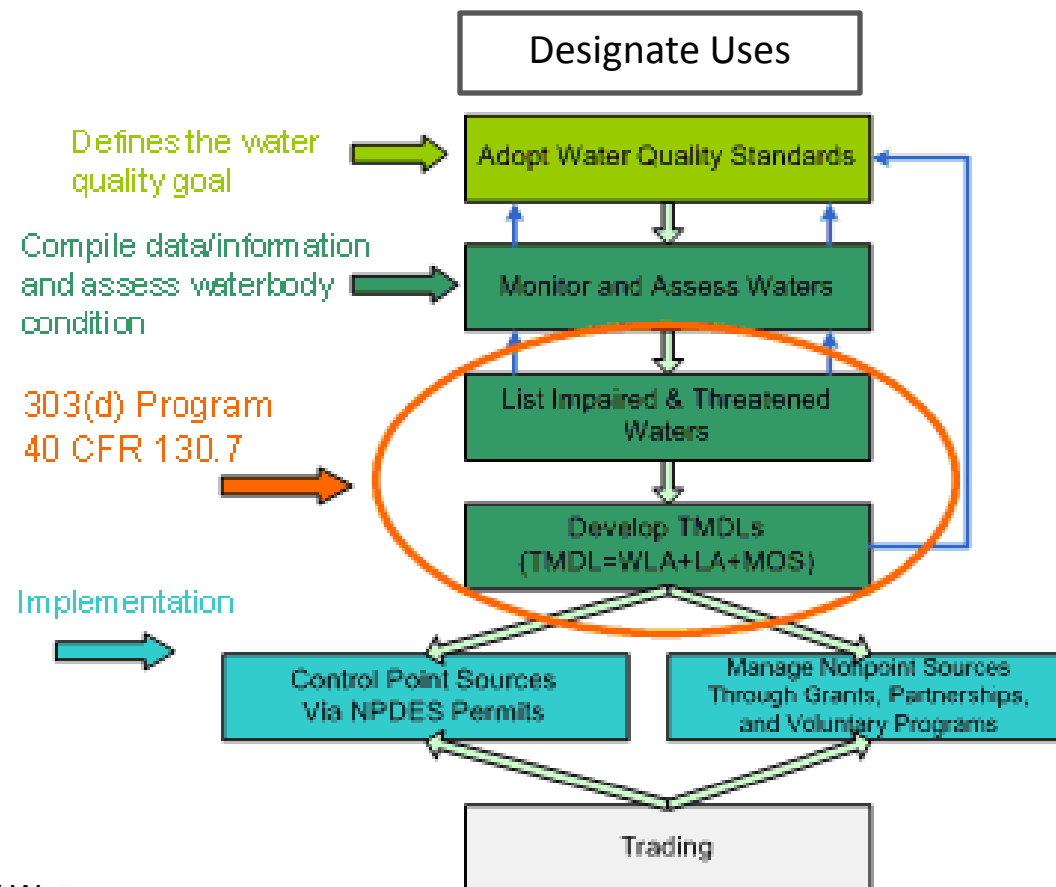
- Water use thresholds determined using the Tennant method, developed in 1976
- The Tennant method
 - assumes that some percentage of the mean flow is needed to maintain a healthy stream environment
 - environmental quality of different flows determined by the quality of the physical habitat provided (stream width, depth, and velocity)

(Jowett, 1997)

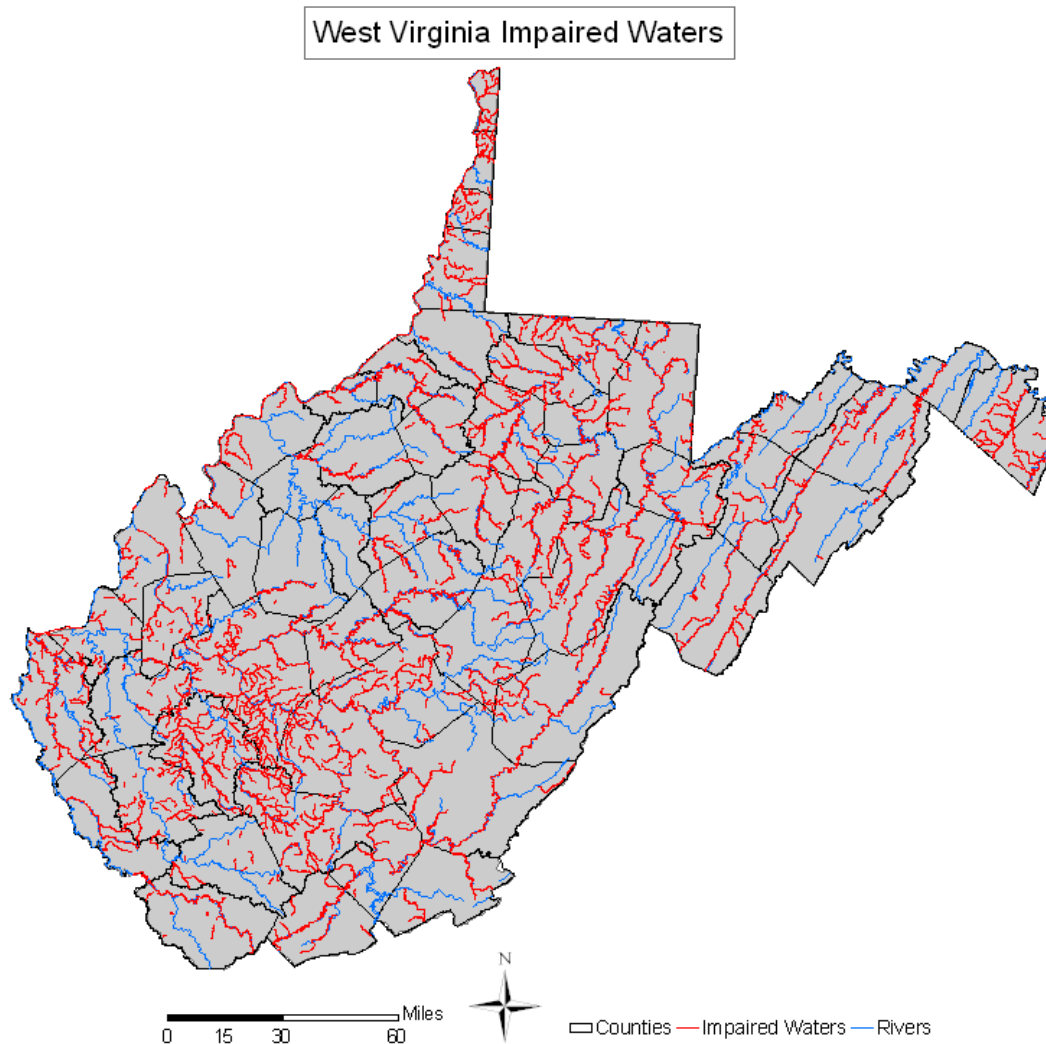


Water quality

- US Clean Water Act (1972) Goal: "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters"



Water quality (cont'd)



57% of WV rivers
and streams
assessed

Of those, 56% are
impaired



Water quality (cont'd)

- WV Impairments

Cause of Impairment Group	Size of Assessed Waters with Listed Causes of Impairment	
	Rivers and Streams (miles)	Lakes, reservoirs, and ponds (acres)
Ammonia	5.4	
Cause unknown - impaired biota	5,152.1	
Dioxins	359.2	
Flow alteration(s)	44.3	
Mercury	669.0	12,018.0
Metals (other than Mercury)	4,455.6	54.0
Nutrients	30.7	100.0
Organic enrichment/Oxygen depletion	23.4	8.0
Pathogens	4,152.8	
pH/Acidity/Caustic conditions	1,378.1	
Polychlorinated Biphenyls (PCBs)	1,056.4	9,198.0
Salinity/Total dissolved solids/Chlorides/Sulfates	21.6	
Sediment		193.0
Temperature	178.7	
Toxic inorganics	0.2	



Water Quality (cont'd)

- A Total Maximum Daily Load (TMDLs) must be developed for each impaired water body
- A TMDL is “a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.”

“Waste Load Allocation”
Point sources

“Load Allocation”
Non-point
& background sources

“Margin of Safety”

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$



Water Quality (cont'd)

- TMDL process:
 - Identify pollutant of concern
 - Estimate waterbody loading capacity
 - Estimate pollutant loading from all sources (pt and nps)
 - Quantify pollutant reductions needed to meet water quality standards
 - Allocation (+ margin of safety) of pollutant load among the sources to meet water quality standards
 - Public review and comment



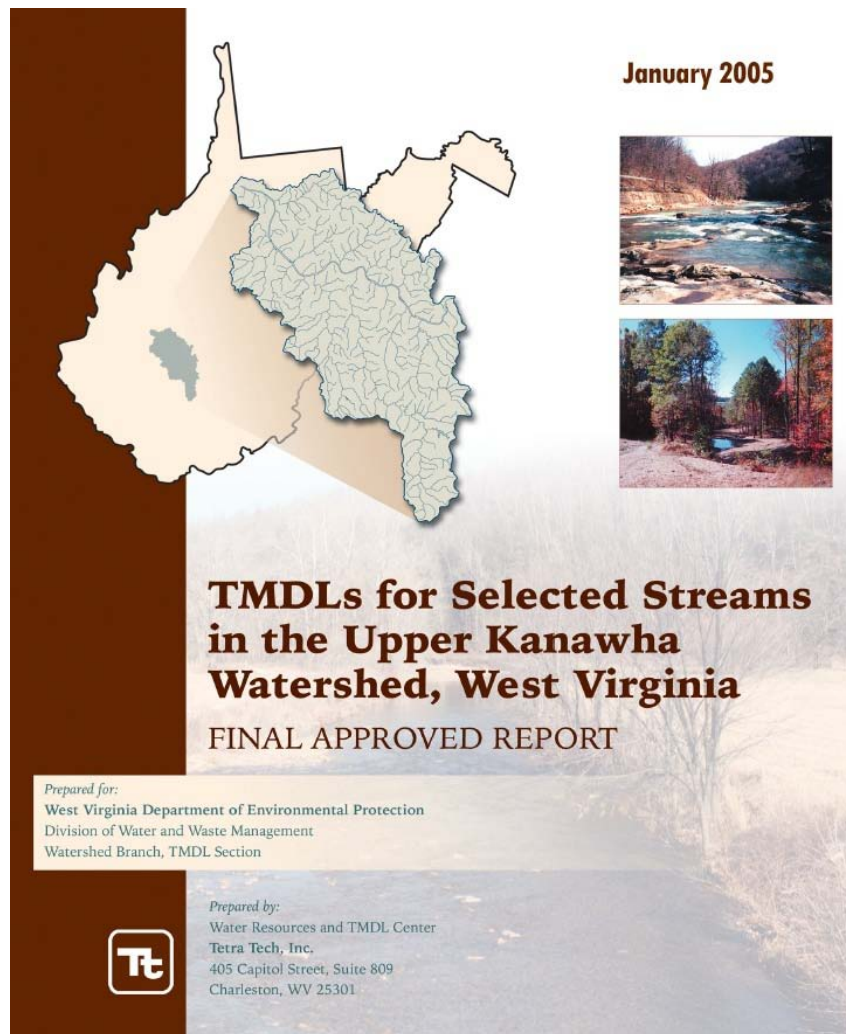
Water Quality (cont'd)

- WV TMDLs for selected pollutants
 - Cumulative since October 2005

Pollutant	Number of TMDLs
Iron	716
Aluminum	454
Fecal Coliform	450
Manganese	397
pH	289
Sediment	83
Biological	80
Acid	27
Organic Enrichment	13
Selenium	13
Chloride	7
PCBs	7
Phosphorus	6



TMDL example – Morris Creek, WV

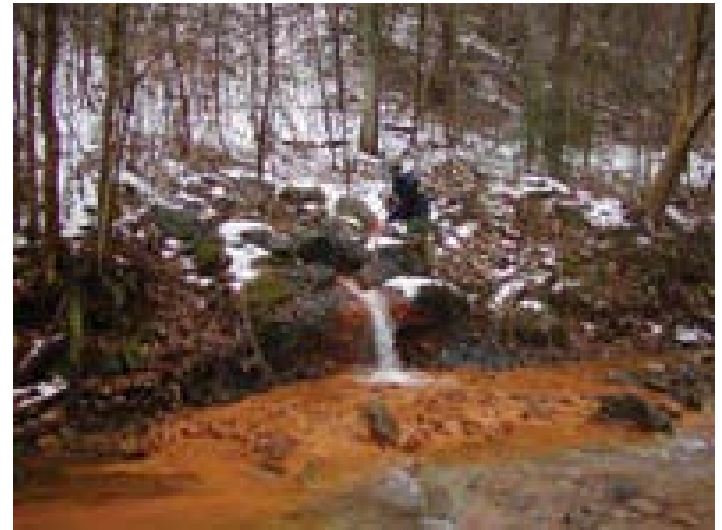


- Located in Kanawha County, 25mi. SE of Charleston
- Listed since 1996 as impaired for metals and pH due to acid mine drainage from abandoned coal mines



TMDL example – Morris Creek, WV

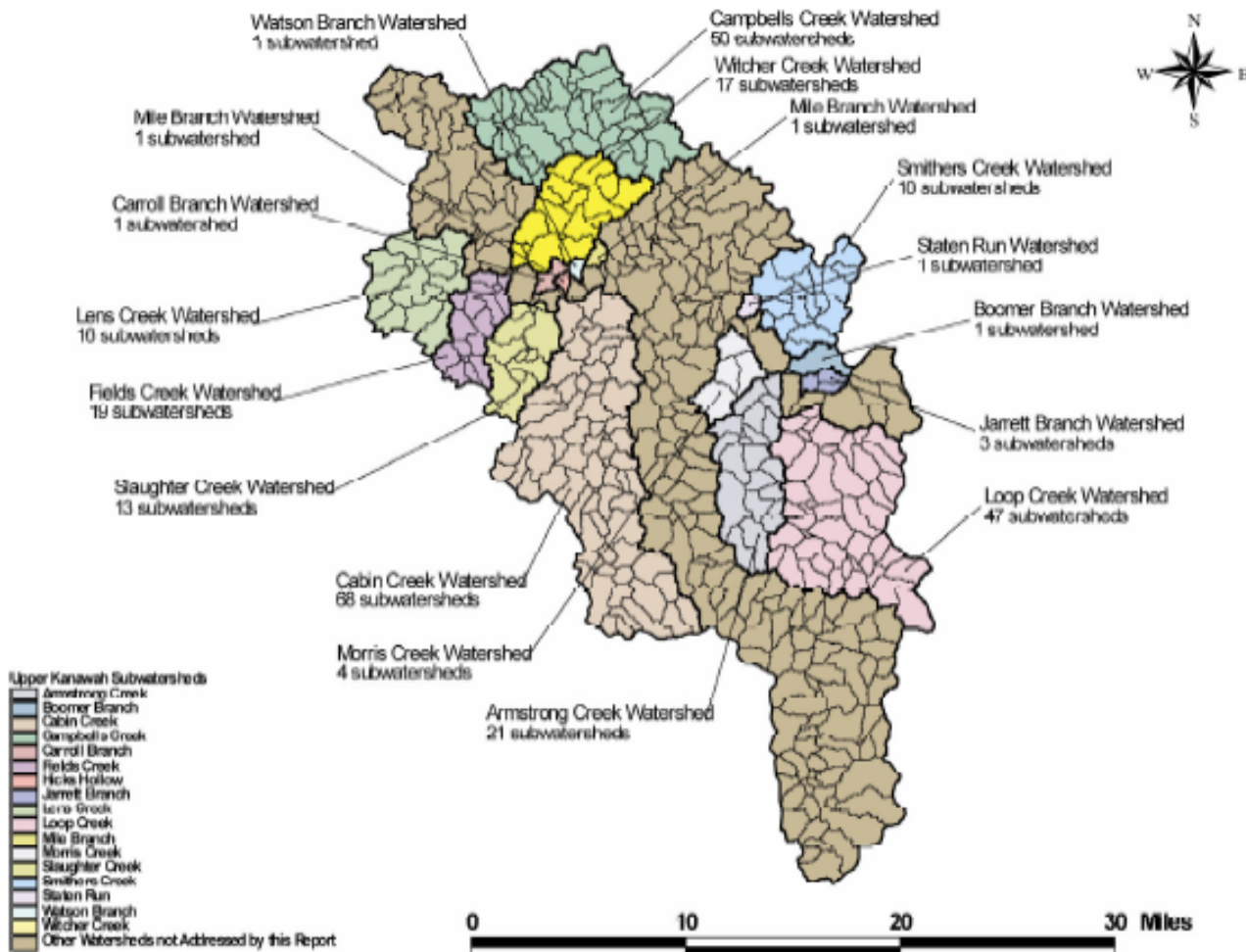
- Morris Creek designated uses:
 - warm-water fishery
 - drinking water
 - contact recreation
- Morris Creek declared impaired due to lack of aquatic life and deposits of iron and aluminum on the streambed



Acid mine drainage in a tributary to Morris Creek
Source: EPA



TMDL example – Morris Creek, WV



TMDL results for Morris Creek to achieve water quality standards:

- aluminum reduction of 5,900 lbs/yr
- iron reduction of 8,007 lbs/yr
- manganese reduction of 4,444 lbs/yr



TMDL example – Morris Creek, WV



Limestone lined drainage channel
Source: EPA

- Restoration efforts: anaerobic and aerobic wetlands, open limestone channels, and polishing ponds at four sites in the watershed
- Water quality improved immediately after treatment system installation
- Expected to be de-listed in 2010
- Treatment system maintenance ongoing



TMDL example - Morris Creek, WV

Project site	pH level: pre/post treatment	Metal reductions achieved		
		Aluminum (lbs/yr)	Iron (lbs/yr)	Manganese (lbs/yr)
Possum Hollow	3.5/6.7	390.55	47.45	102.2
Blacksnake Hollow	4.4/5.0	84.45	76.65	36.86
Lower Mainstem	4.0/6.3	1,759.3	9,249.1	1,098.65
Upper Mainstem	4.2/5.4	31,006.75	276,483.85	31,119.9
Total Reductions	--	33,248	285,857	32,320
TMDL Allocations	--	5,900	8,007	4,444

Source: EPA



Summary

- Environmental flows
 - Essential to maintaining ecosystem integrity in West Virginia
 - Assessment/protection methods: % of flow, WV water withdrawal guidance tool
 - ICPRB/TNC/CoE 2.5 yr project to quantify environmentally sustainable flows in the Potomac Basin (www.potomacriver.org)
- Water quality
 - Regulated under the US Clean Water Act
 - 57% of WV rivers and streams assessed, 56% of which are impaired
 - TMDLs developed for many impaired waters, with some success stories, but more work remains



References

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- Tennant, D. L. 1976. 'Instream flow regimens for fish, wildlife, recreation, and related environmental resources', in Orsborn, J. F. and Allman, C. H. (Eds), *Proceedings of the Symposium and Speciality Conference on Instream Flow Needs II*. American Fisheries Society, Bethesda, Maryland. Jowett, I.G. 1997. Instream flow methods: A comparison of approaches. *Regulated Rivers: Research and Management*. 13:115-127.

