



INSTREAM FLOW STANDARDS: DRIVERS AND OBJECTIVES



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Southeast Aquatic Resource Partnership
Southern Instream Flow Network
Second Annual Conference
Nashville, Tennessee
December 1, 2009



**SETTING INSTREAM FLOW STANDARDS:
WHAT DO WE NEED TO KNOW?**

SESSION OUTLINE

- **3:30 Introduction** (Eloise)
- **3:40 Case studies:**
 - Michigan (Rich Bowman, TNC)
 - Colorado (Thomas Wilding, CSU)
 - Connecticut (Mark P. Smith, TNC)
 - Summary comparison (Eloise, TNC)
- **4:15 SIFN test case:**
 - Tennessee (Robby Baker, TDWPC)
- **4:25 State-by-state facilitated discussion**
 - Drivers, objectives, and constraints
 - Short, mid, and long-term goals



IDEAL INSTREAM FLOW PROGRAM

- Apply to *all* rivers
- Best available science
- *Patterns* of flow
- Explicit link to ecological goals
- Stakeholder-driven
- Implementable
- Groundwater *and* surface water
- Protection *and* restoration
- Monitoring, enforcement, refinement



DEFINITIONS

Criteria, Standards: *water bodies*

Limits & Operations: *water users*

Instream Flow Programs:

- Set flow standards to meet ecological condition goals
- Define withdrawal limits and release requirements to meet the standards



DEFINITIONS

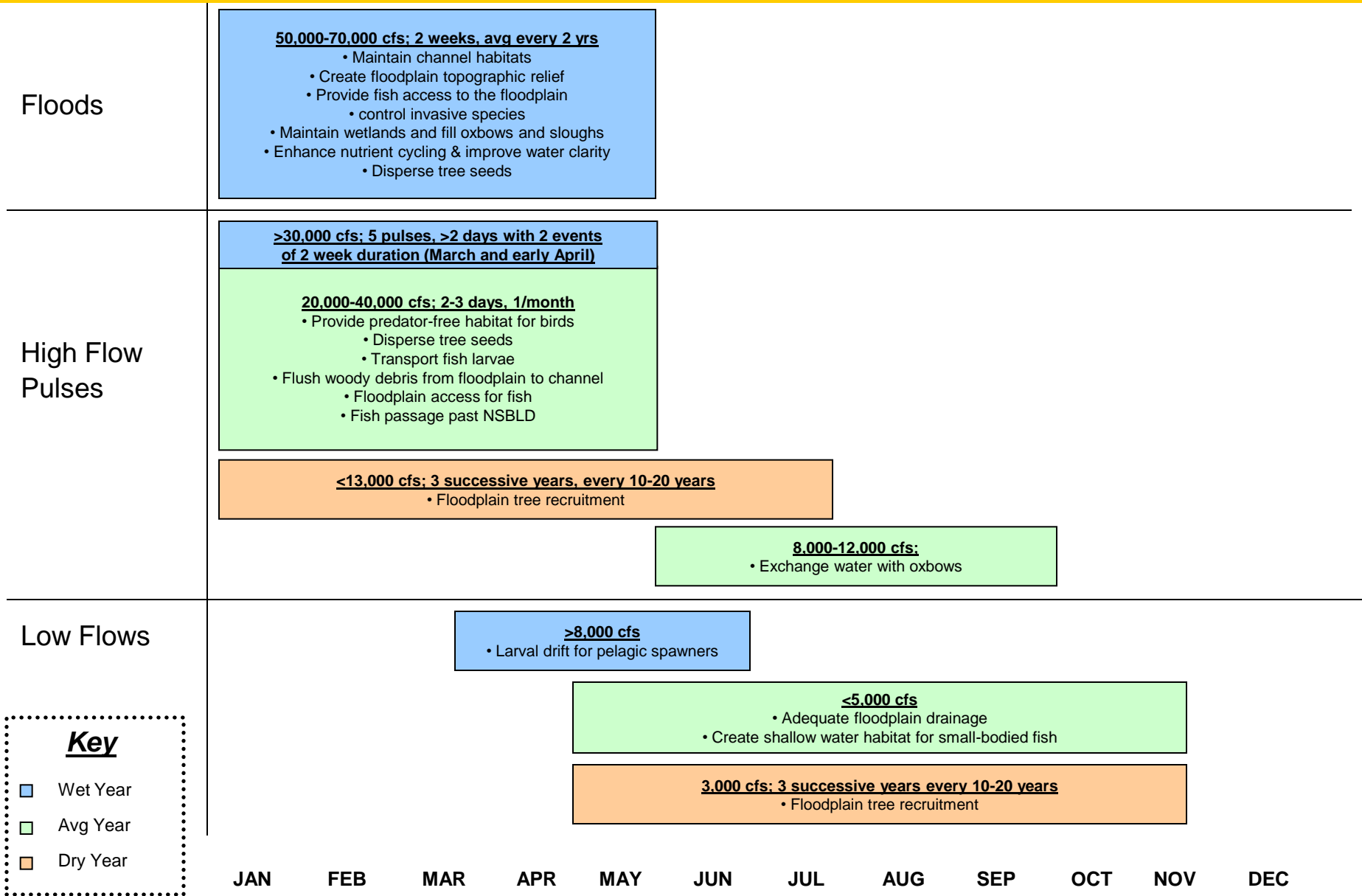
Criteria (or standards) are environmental conditions that are flow 'goals' that must be met on a consistent basis.

These are the desired environmental outcomes and can be expressed in narrative or numeric form.

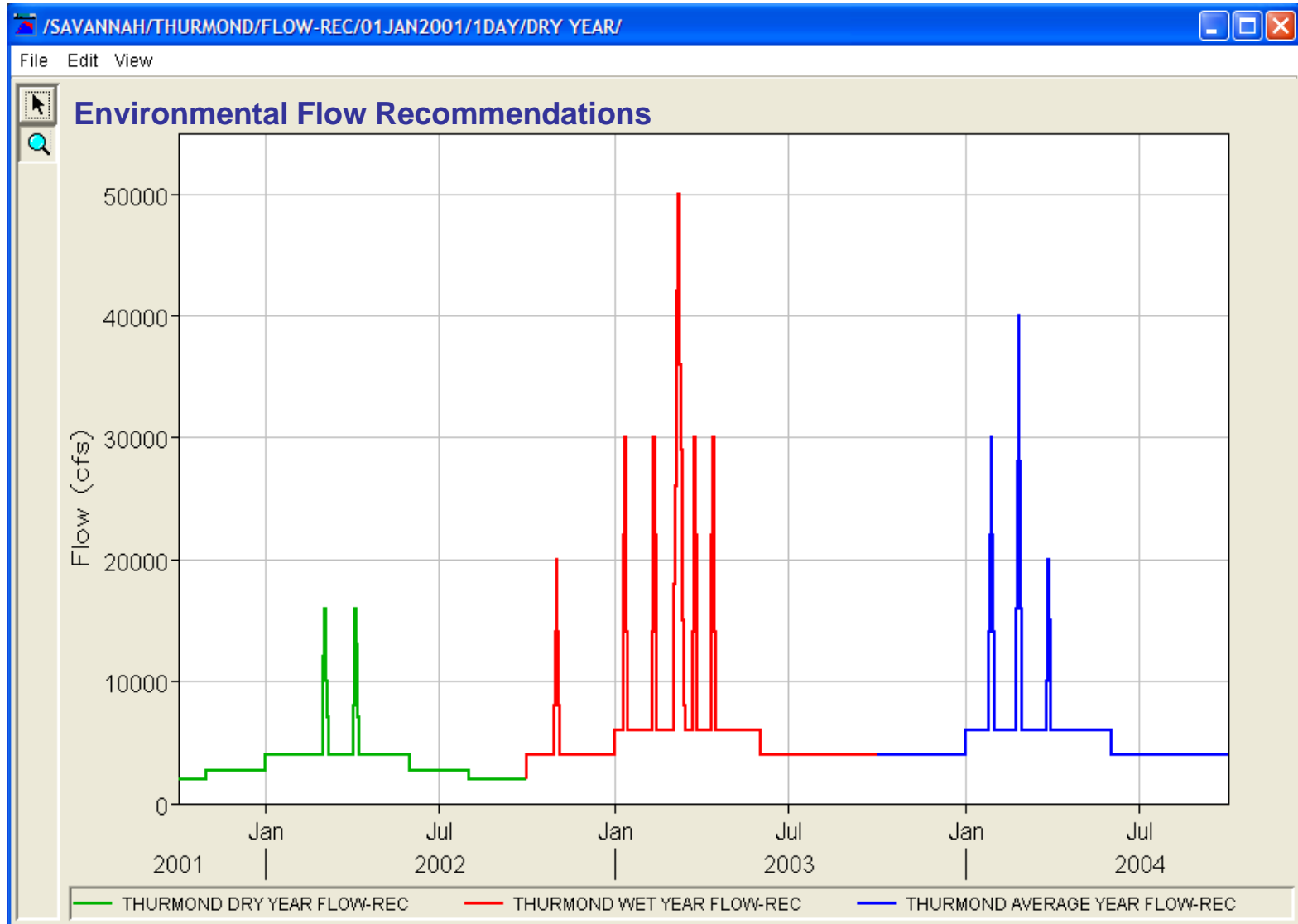


Threshold Standard

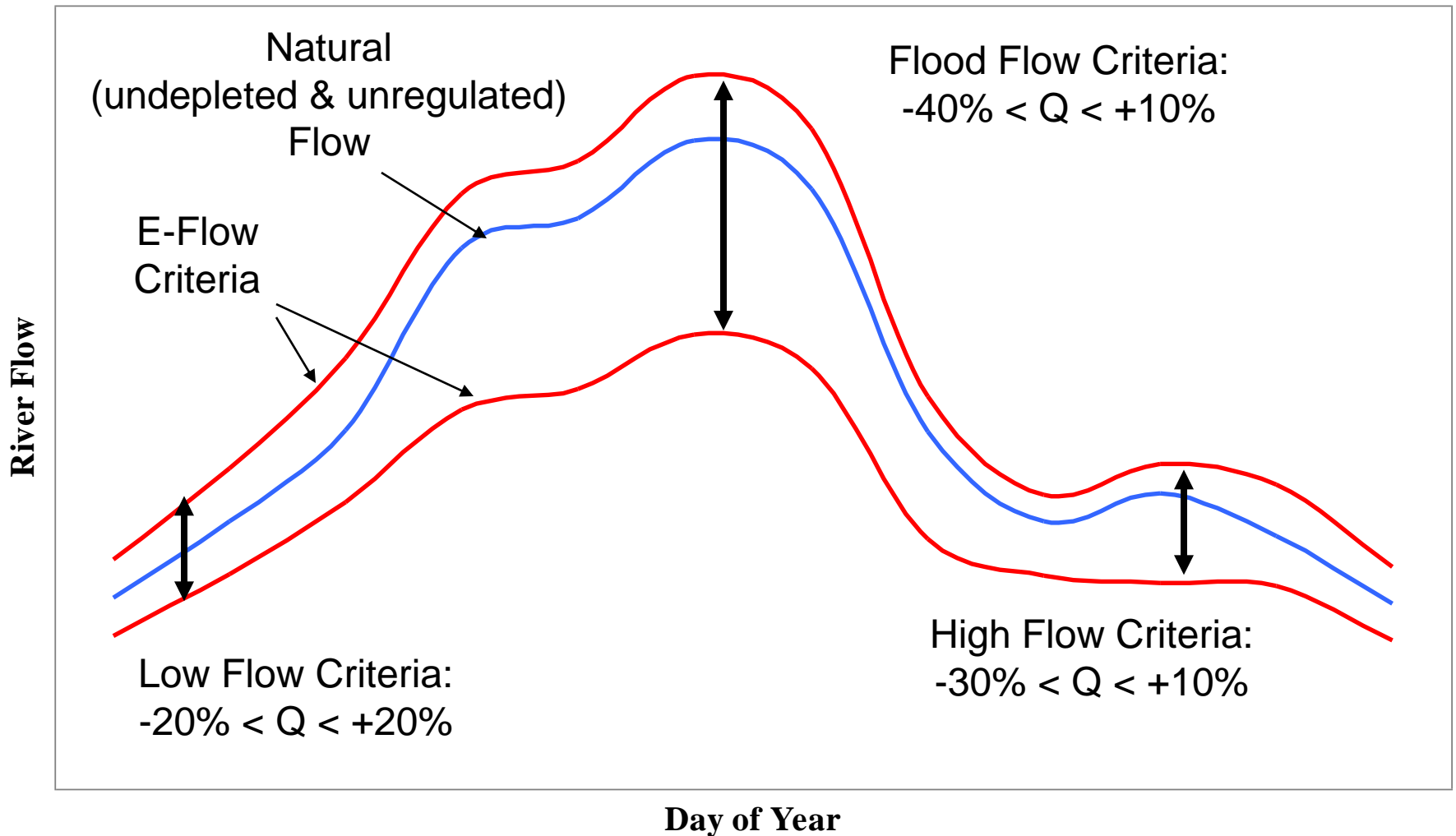
Savannah River, below Thurmond Dam (*River-Floodplain*)



Threshold Standard



Percent-of-Flow Standard



Richter B. D. (2009) Re-thinking environmental flows: from allocations and reserves to sustainability boundaries. *River Research and Applications* online.

Percent-of-Flow Standard

		River Type				
		1 (Ground-water-Fed)	2 (Snowmelt-Driven)	3 (Large floodplain)		N (Etc)
River Condi- -tion Goal	Excellent/ unmodified or near- natural	Low a% High b% Flood c%	Low d% High e% Flood f%	Low g% High h% Flood i%		Low n% High o% Flood p%
	Good/ Slightly modified	Low a+% High b+% Flood c+%	Low d+% High e+% Flood f+%	Low g+% High h+% Flood i+%		Low n+% High o+% Flood p+%
	Acceptable/ Moderately modified	Low a+++% High b+++% Flood c+++%	Low d+++% High e+++% Flood f+++%	Low g+++% High h+++% Flood i+++%		Low n+++% High o+++% Flood p+++%

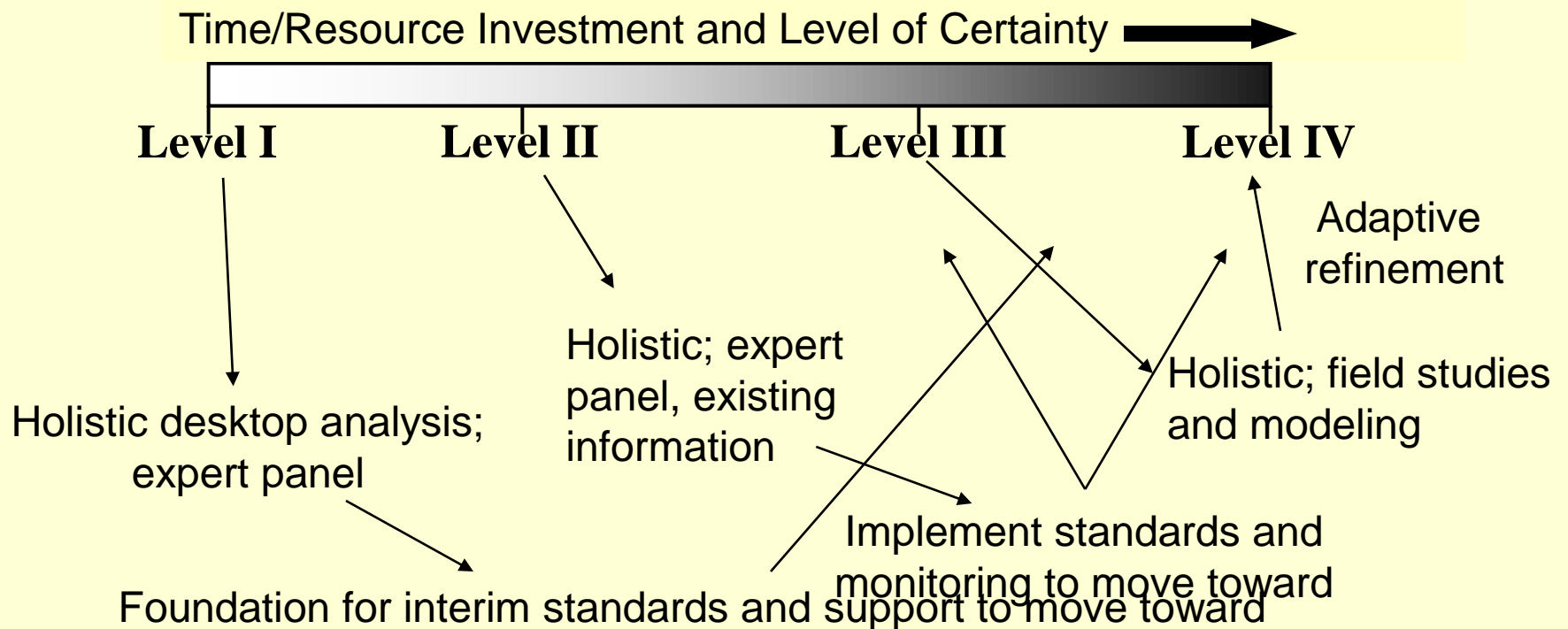
DEFINITIONS

Limits & Operations are quantities of water that are allowed to be withdrawn or the specific requirements for releases at any particular time.

- **Withdrawal permit conditions**
- **Reservoir operating rules**

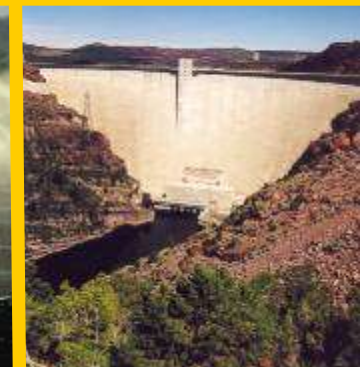


STEPWISE APPROACH: IMPLEMENTATION, MONITORING, REFINEMENT



CASE STUDIES

- What is the driver?
- What is the objective?
- How will flows be implemented?
- What are the constraints?
- What is achievable?





Colorado's Water
Supply Future



Brassy minnow



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COLORADO STATE UNIVERSITY

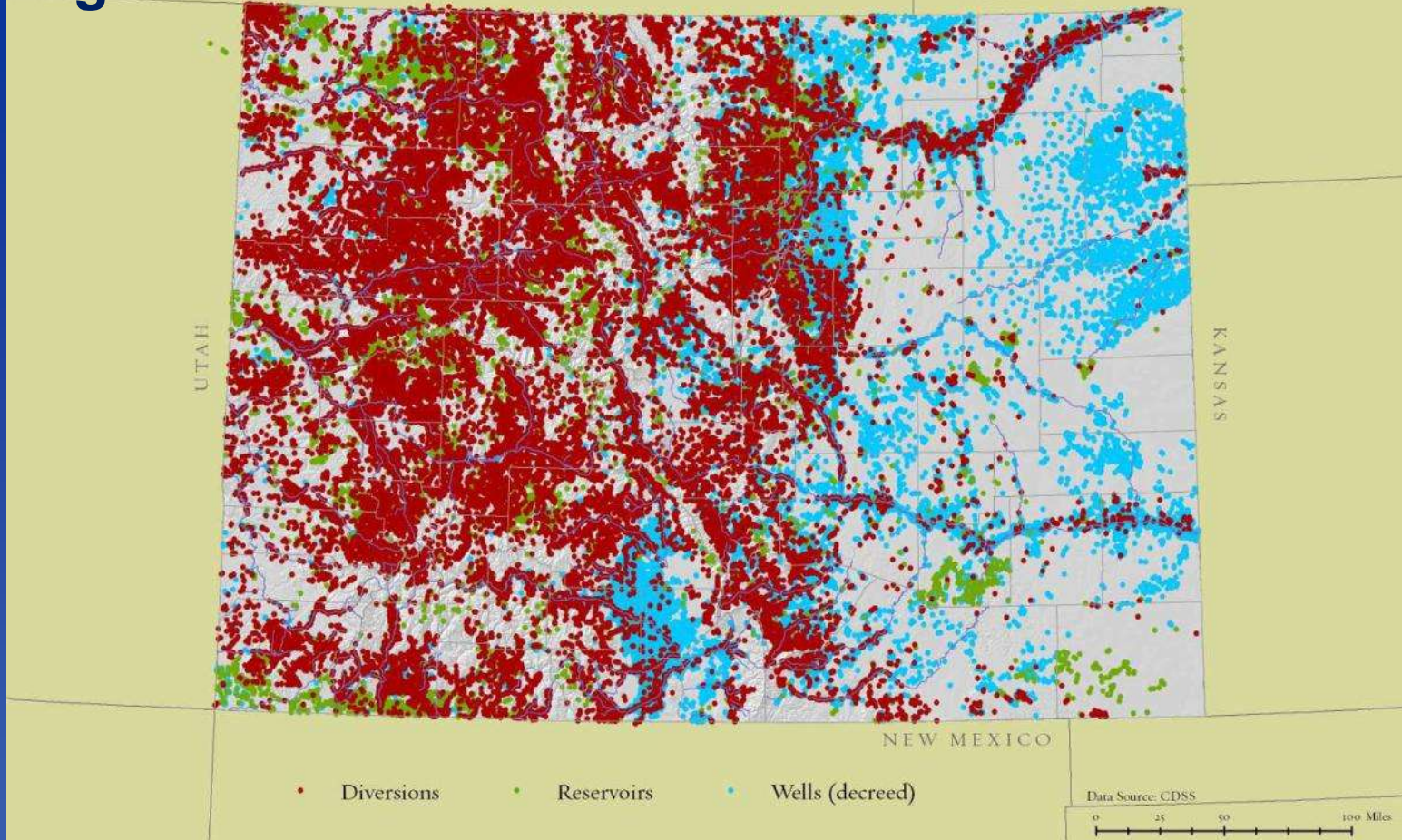
The Watershed Flow Evaluation Tool: Colorado's ELOHA Application

John Sanderson, The Nature Conservancy
Nicole Rowan, Camp Dresser McKee Inc.
Thomas Wilding, Colorado State University
LeRoy Poff, Colorado State University
Brian Bledsoe, Colorado State University
Bill Miller, Miller Ecological Consulting

November 18, 2009



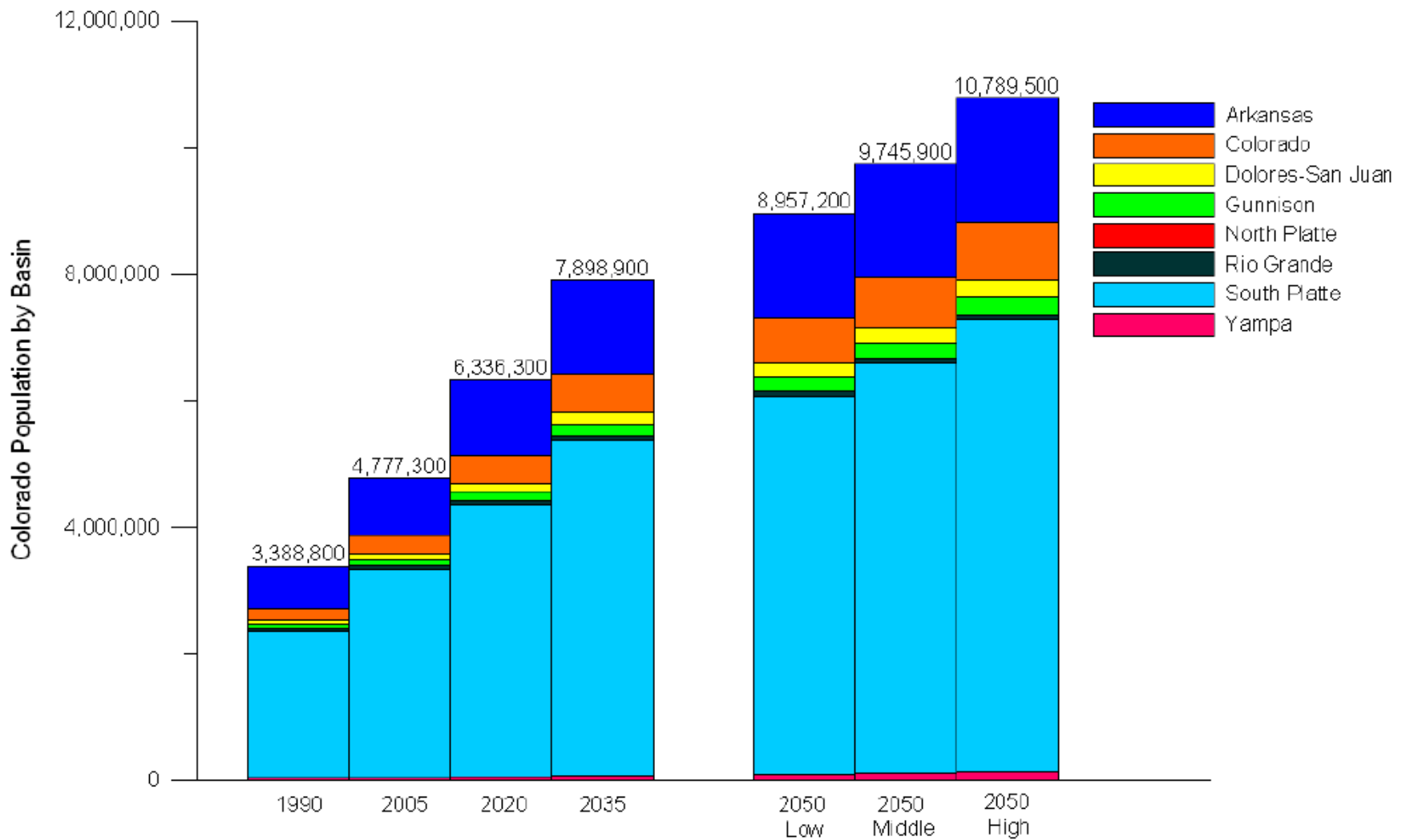
High Water Demand!



- More than 45,000 diversions statewide, diverting 80% of Colorado's annual runoff.
- 10% of Colorado's native fish are gone from the state. Of the remaining, 45% are listed as endangered, threatened, or of special concern.
- Colorado water is governed by prior appropriations doctrine; we have no instream flow standards to protect rivers from excessive development.

Exhibit 25.
COLORADO POPULATION PROJECTIONS BY BASIN

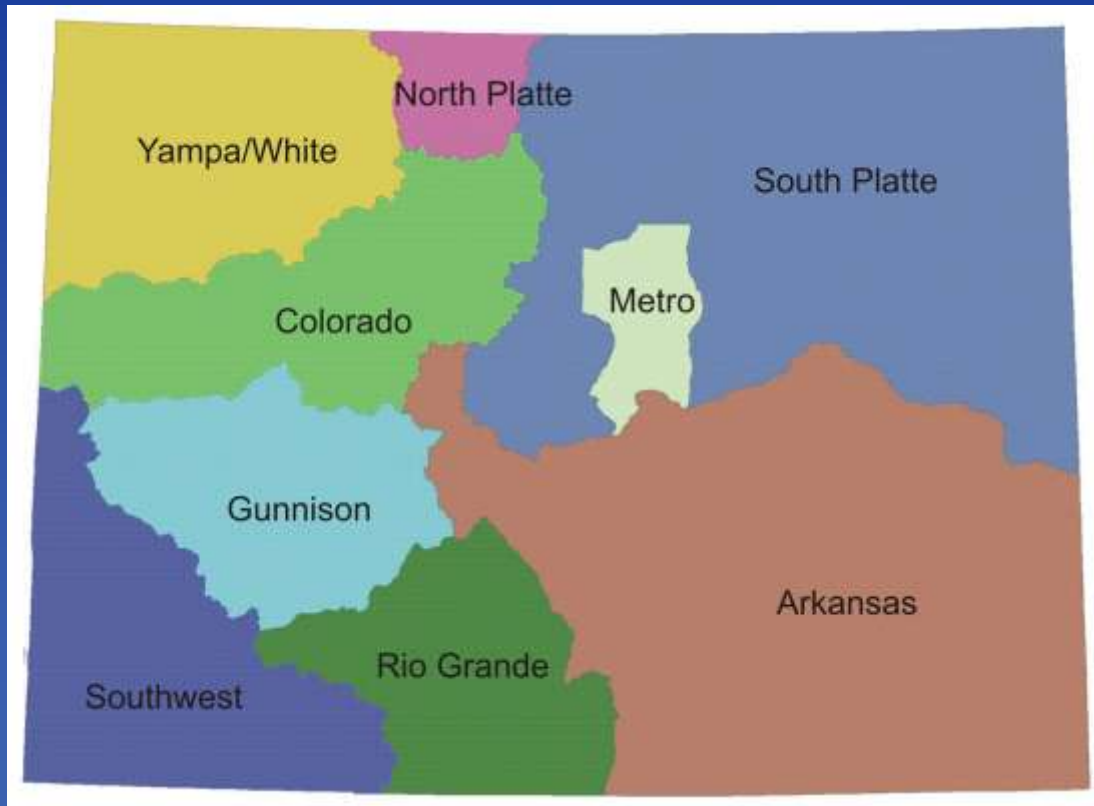
Source: Harvey Economics 2008



By 2030, projected M&I increase: 53% (630K AF)

By 2050, projected increase: 69-142% (830K – 1.7M AF)

HB05-1177 Water for the 21st Century Act



- Consumptive Needs
- Nonconsumptive Needs
- Water Supply Availability
- Projects and Methods to Meet Needs

Establish 9 basin Roundtables of water users and conservation representatives

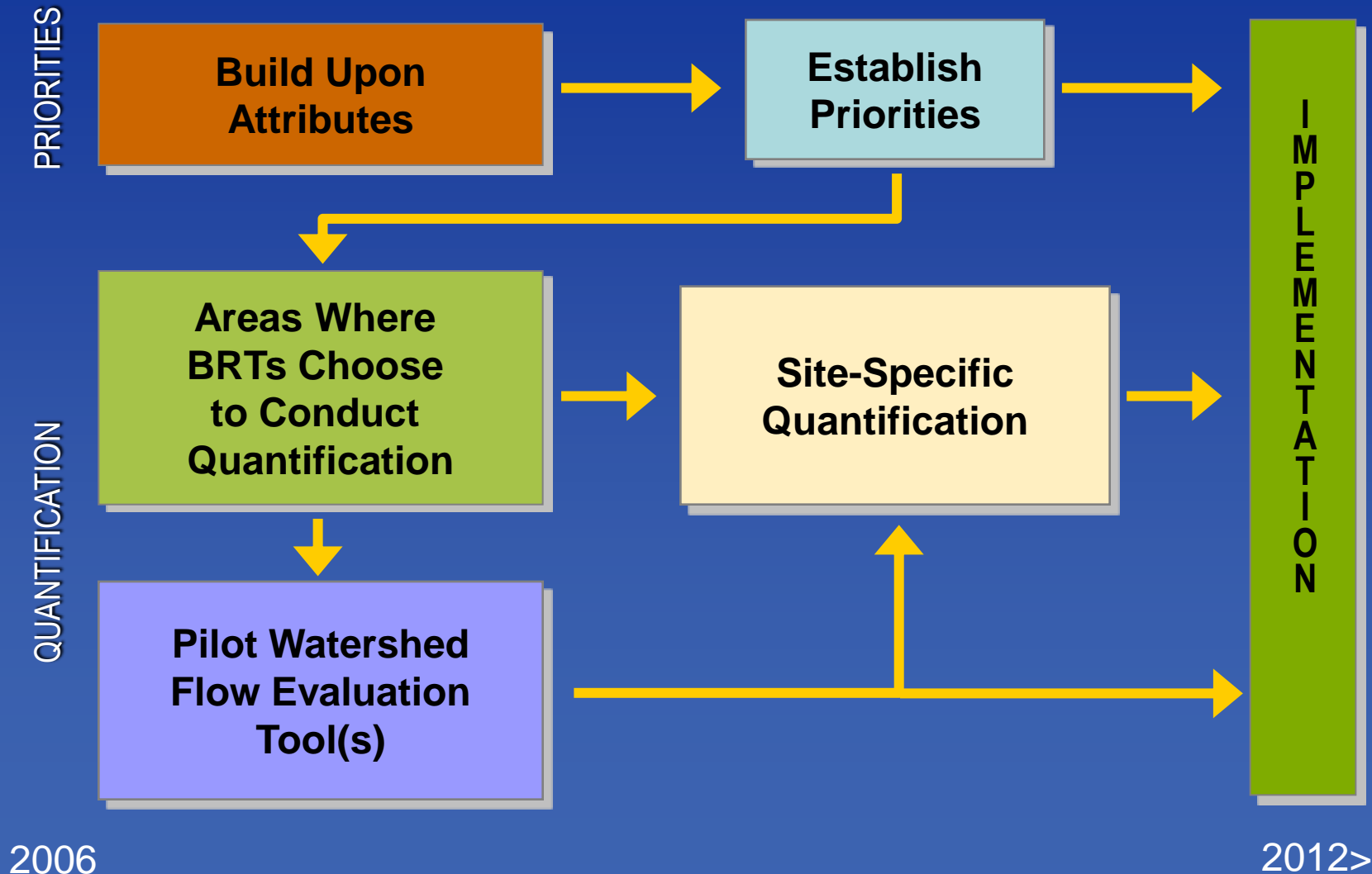
Exact wording of House Bill 05-1177

- “Develop a basin-wide consumptive and nonconsumptive water supply needs assessment, conduct an analysis of available unappropriated waters within the basin, and propose projects or methods, both structural and nonstructural, for meeting those needs and utilizing those unappropriated waters”
- “Serve as a forum for education and debate regarding methods for meeting water supply needs”

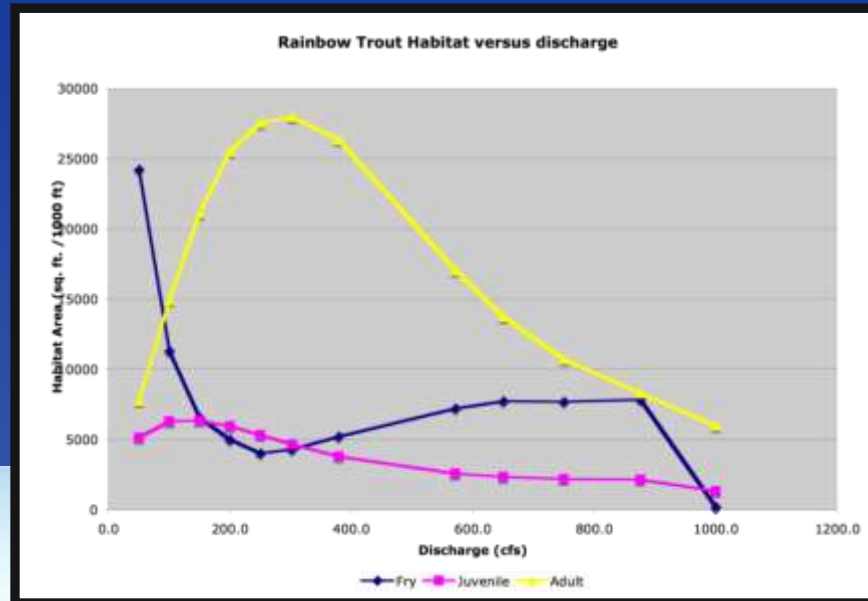
This is a planning initiative for future water development, not a regulatory or standard setting process.

Future water supply projects can be evaluated not just in terms of “is the water there to take”.

Nonconsumptive Needs Assessment Process



Quantifying non-consumptive flow needs: Site specific assessments



High flow (875 cfs)



Low Flow (300 cfs)

That's one site; how do we scale up?

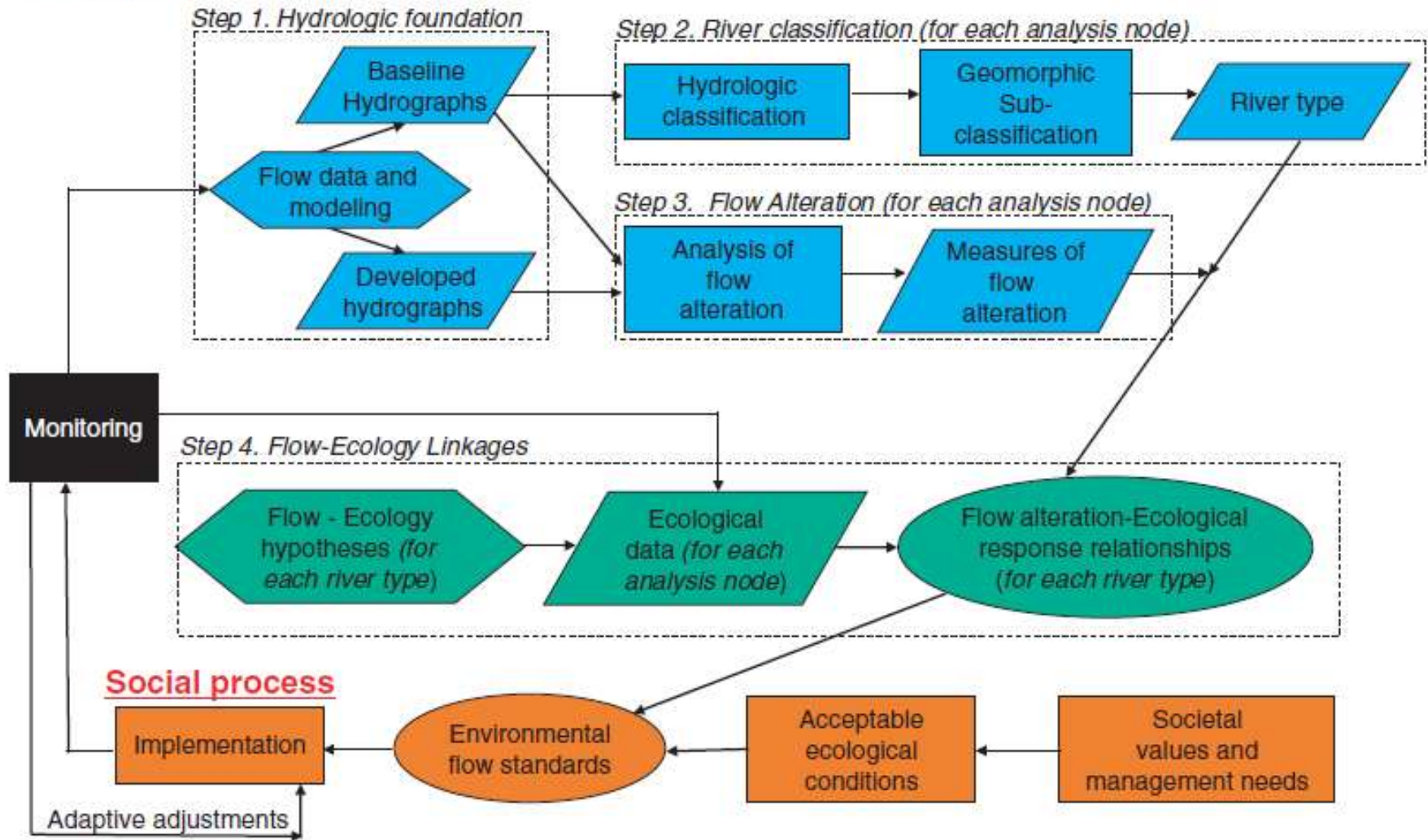
Colorado's Answer:
the Watershed Flow Evaluation Tool

The WFET . . .

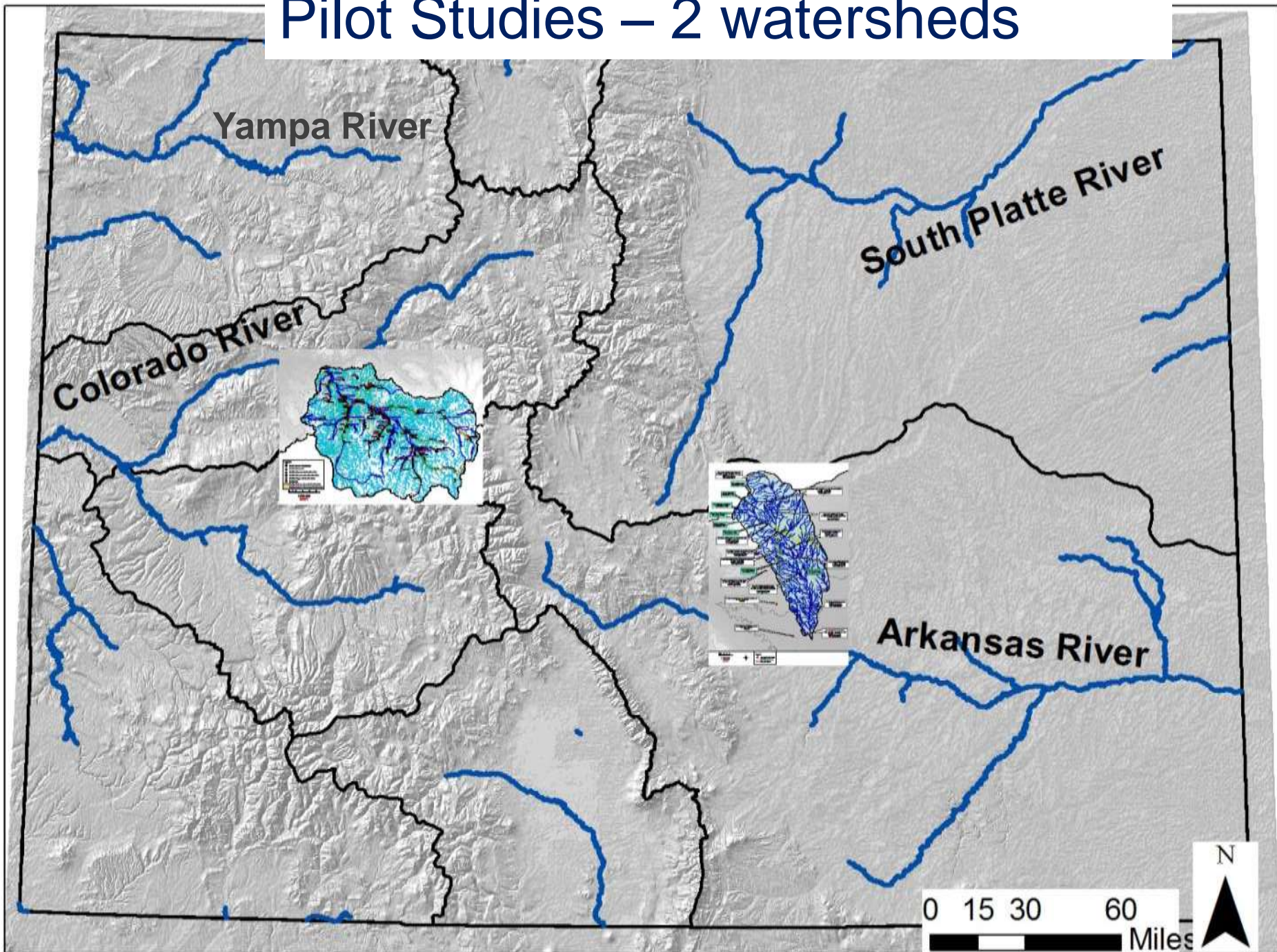
- Addresses many rivers simultaneously
- Explicitly links flow and ecological response
- Can be applied across a spectrum of flow alteration types, data availability, scientific capacity, and social contexts

ELOHA: Ecological Limits of Hydrologic Alteration

Scientific process



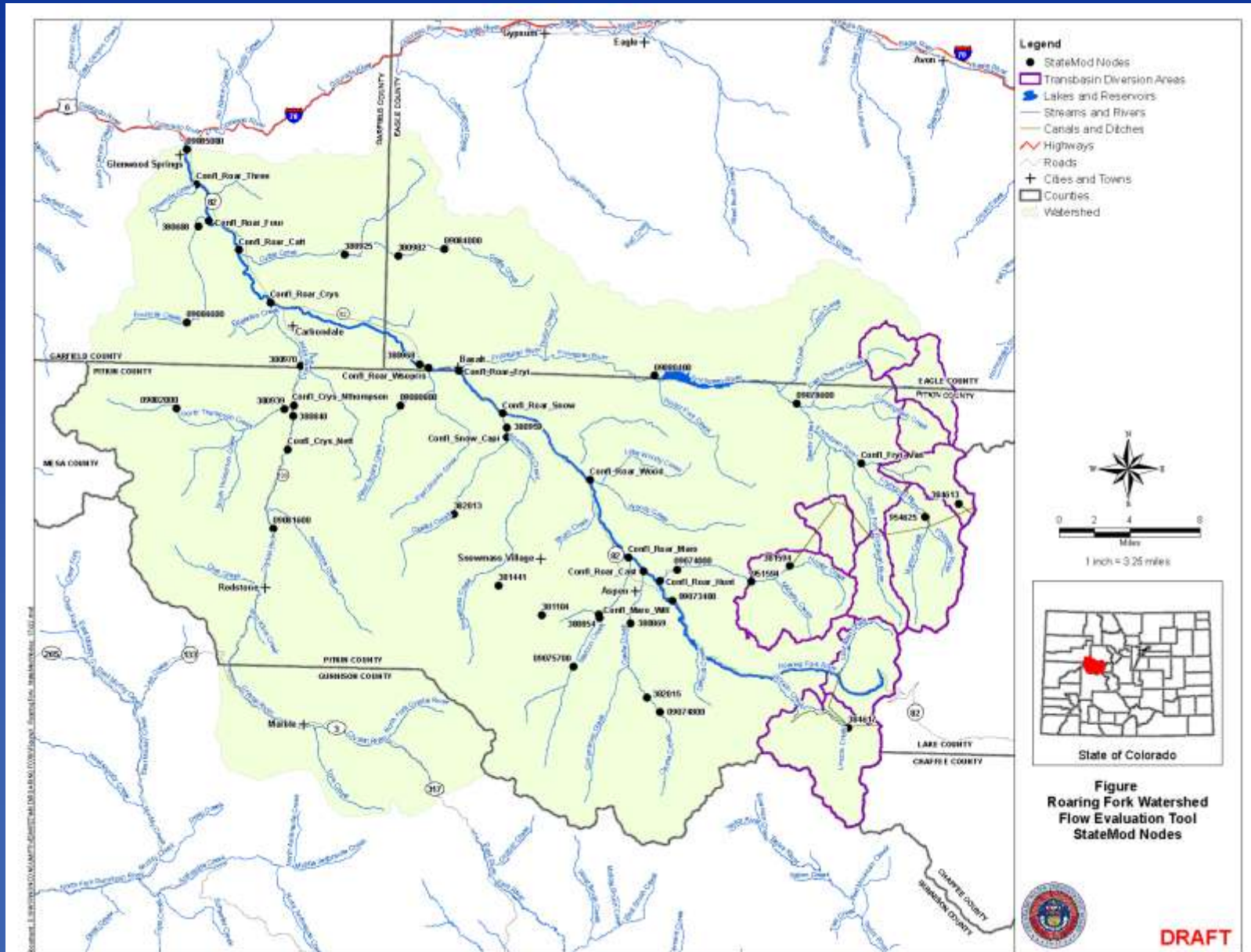
Pilot Studies – 2 watersheds



Steps Utilized for WFET Pilot Studies

1. Hydrologic foundation – used Colorado Decision Support System (CDSS) Model and USGS Gages
2. Utilized The Nature Conservancy's Indicators of Hydrologic Alteration (IHA) software to analyze hydrologic data
3. Developed Flow Ecology relationships for key flow metrics generated by IHA
4. Developed mapping showing areas that may be at risk due to changes in flow regime

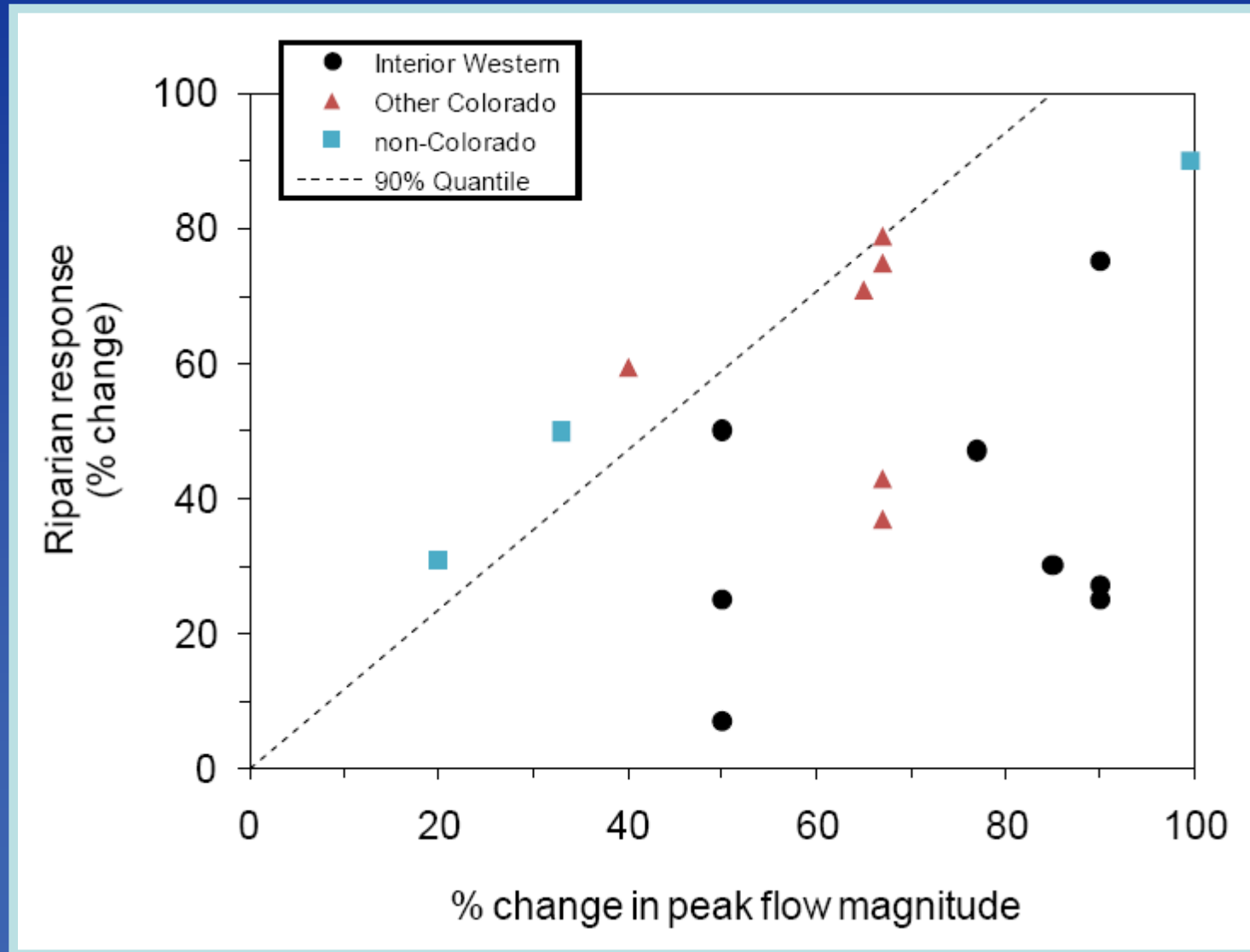
Step 1: Build a hydrologic foundation



Step 2: Calculate flow metrics

- IHA analysis completed for baseline and current hydrology for following flow statistics:
 - August and September mean flow (cfs)
 - January mean flow (cfs)
 - Average annual peak daily flow (cfs)
 - Mean annual flow (cfs)
 - 2-Year Flood Frequency flow (cfs)

Step 3: Develop Flow-Ecology Relationships e.g., Riparian Vegetation



Step 4: Ecological Risk Mapping

- Calculated flow metrics from Flow-Ecology curves at StateMod Nodes and USGS gages
- Assigned risk levels to nodes and gages based on ecological metrics
- Assigned risk level between nodes and gages
- Generated mapping

Assign risk levels to stream segments



WFET Results and Applications

- Produce maps that clearly and quickly convey the ecological risk.
- Stakeholders choose risk levels and estimate water quantities for non-consumptive needs
- Allows watershed-wide screening to target areas that need further site-specific studies
- Supports basinwide assessments of water development scenarios & climate change.
- Support strategic decision-making about the system-wide operations to provide better ecological outcomes.

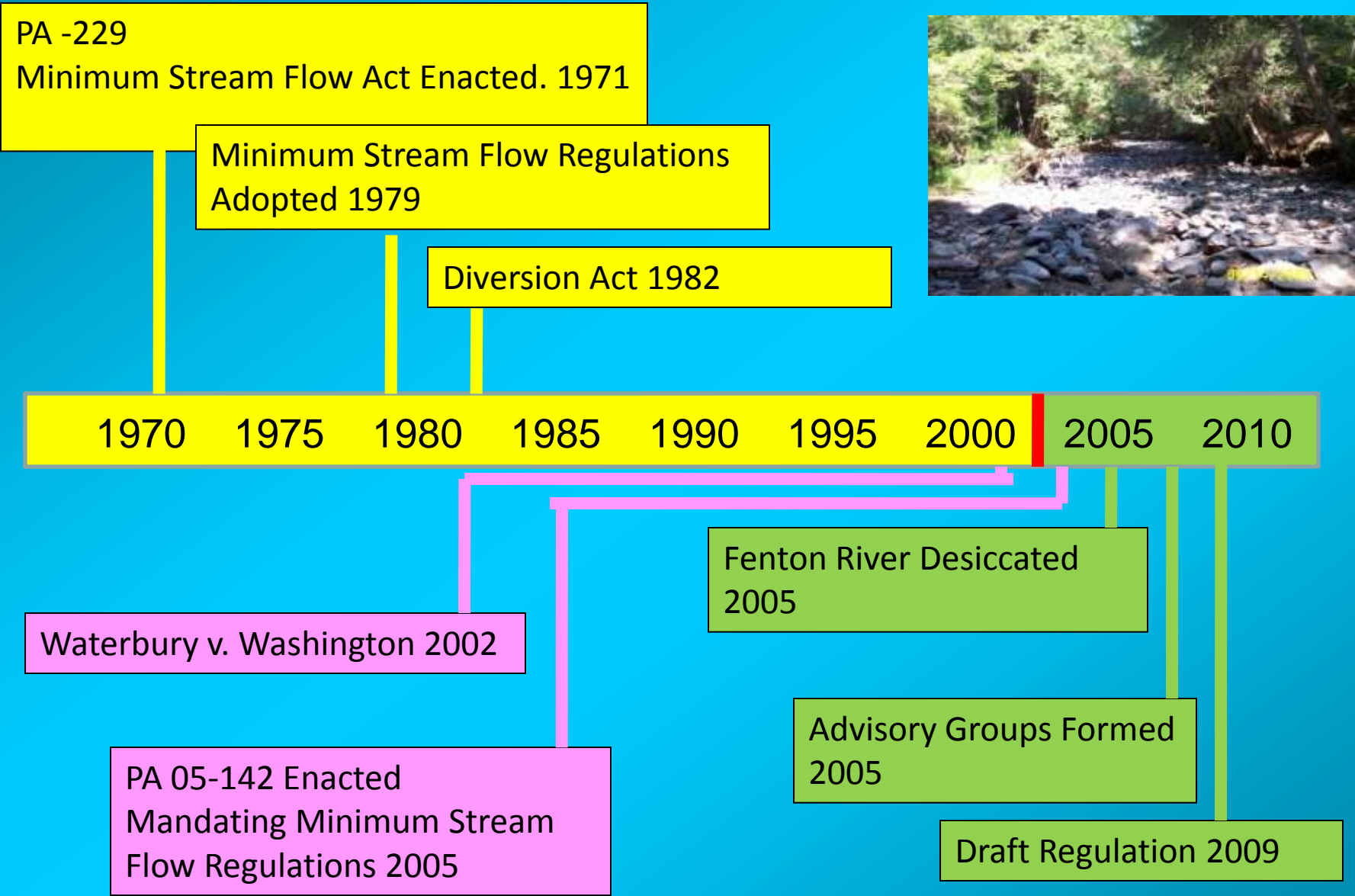


Connecticut Public Act 05-142

Act Concerning the Minimum Water Flow Regulations

- CT DEP Commissioner to Adopt Flow Regulations:
 - Apply to all rivers and streams
 - Preserve and protect natural and stocked aquatic life and wildlife
 - Promote and protect public recreation
 - Be based, to the maximum extent practicable, on natural variations of flows and water levels
 - Provide for the needs and requirements of public health, flood control, industry, public utilities, water supply, public safety, agriculture, and other lawful uses

HISTORY of STREAM FLOW REGULATION



**Commissioner's
Advisory Group**

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graph BT; A[Commissioner's Advisory Group] <--> B[Scientific – Technical Workgroup]; A <--> C[Policy – Implementation Workgroup];
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**Scientific –
Technical
Workgroup**

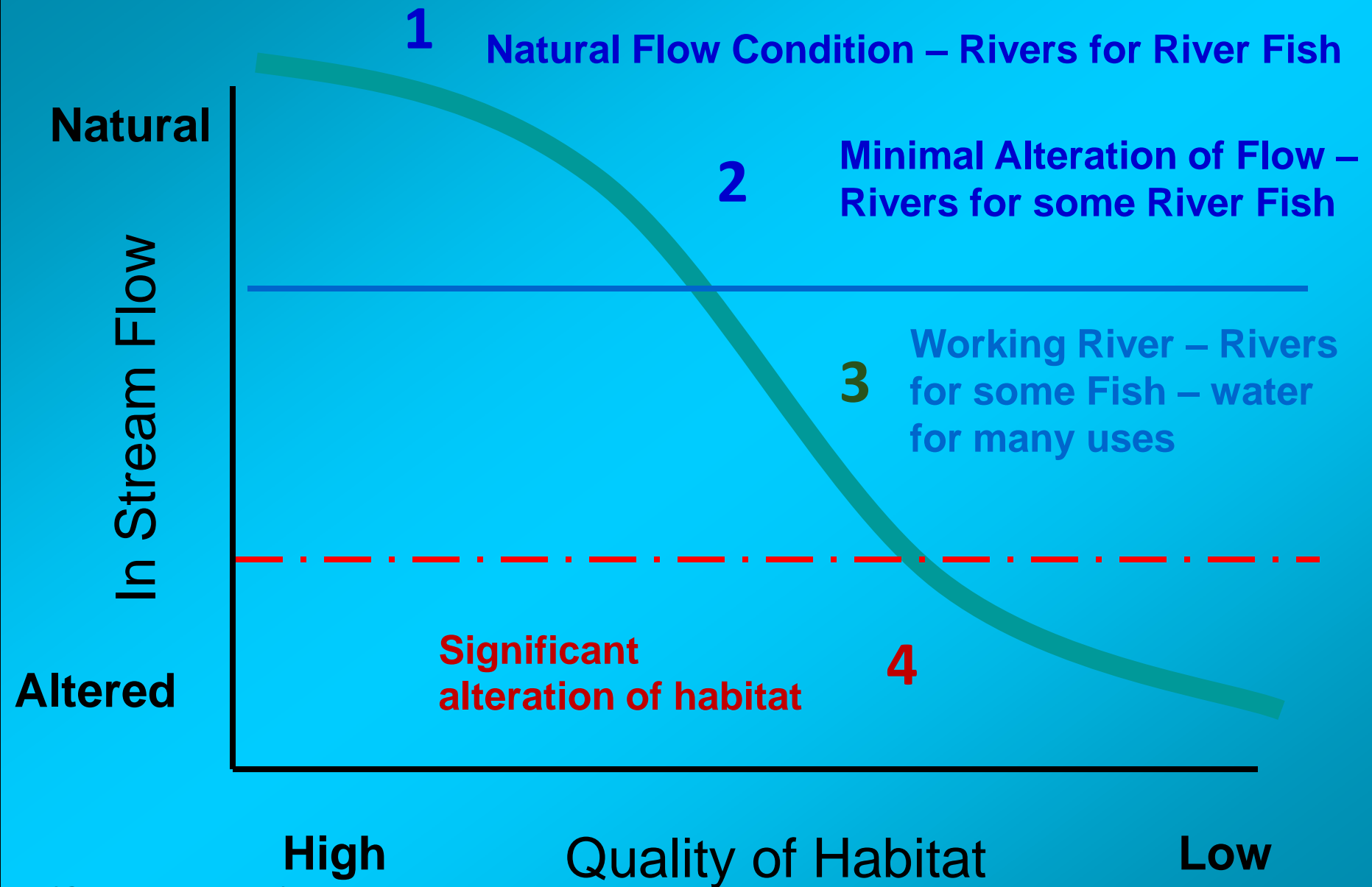
**Policy –
Implementation
Workgroup**

Established December of 2005

Structure of Proposed Regulation

- Classification
- Operation Rules dependent on Classification
- Phased in Compliance
 - Classification Year 0-5
 - Interim Compliance Year 6-11
 - Full Compliance Year 11-16
- Flow Management Plan option at any time

Proposed Stream Flow Classification



Draft Connecticut Standards

Streamflow in Class 1 rivers and streams:

provide for the physical characteristics of flow, depth, volume, and velocity necessary to support and maintain habitat conditions required to support an aquatic biological community **similar to that typically present in free-flowing** river and stream systems of similar size and geomorphic characteristics under the prevailing climatic conditions;

Streamflow in Class 2 rivers and streams:

.....minimally altered from that typically present in free-flowing river.....

Streamflow in Class 3 rivers and streams:

.....moderately altered from that typically present in free-flowing river and stream systems.....

Streamflow in Class 4 rivers and streams:

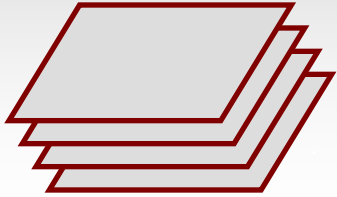
may be substantially altered by human activity as necessary to provide for the legitimate needs and requirements of public health, flood control, industry, public utilities, water supply, public safety, agriculture, and other lawful uses.

What That Tells Us

- Not all streams and rivers in the state are the same
- Not possible to take everything back to pristine
- Different places on the curve call for different management strategies –
- Challenge is to define what where

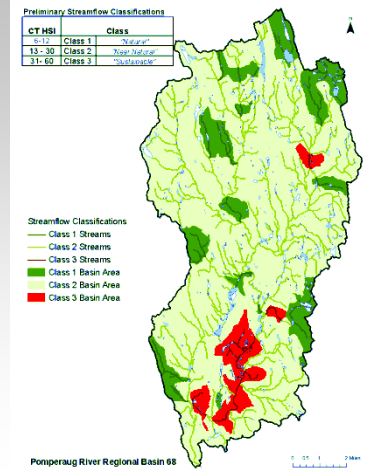
Adopt Stream Flow Classifications

Consider Factors Indicative of the Degree of Human Alteration of Natural Stream Flow

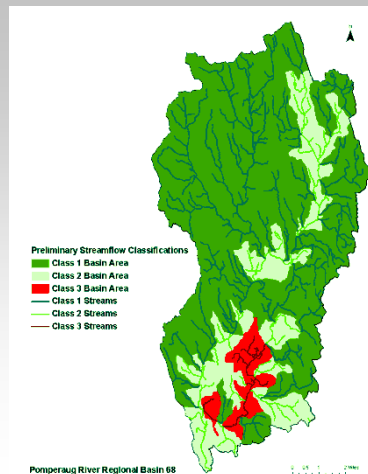


Diversions
Dams
Impervious Cover
Return Flow
Unique Factors

Develop Draft Stream Flow Classes



Adopt Stream Flow Classifications



(CT DEP, 2009)

Propose Stream Flow Classifications, Public Notice, and Solicit Comment



Factors for Consideration in Classification

- Size and location of groundwater withdrawals
- Size and location of planned future withdrawals
- Size and location of dams and impoundments
- Size and location of water and wastewater discharges
- Existing and proposed development
- Presence of flow-sensitive aquatic life
- Location of USGS natural reference stream gages
- Designated open space protected areas
- Physical habitat restoration potential







Text Box 2

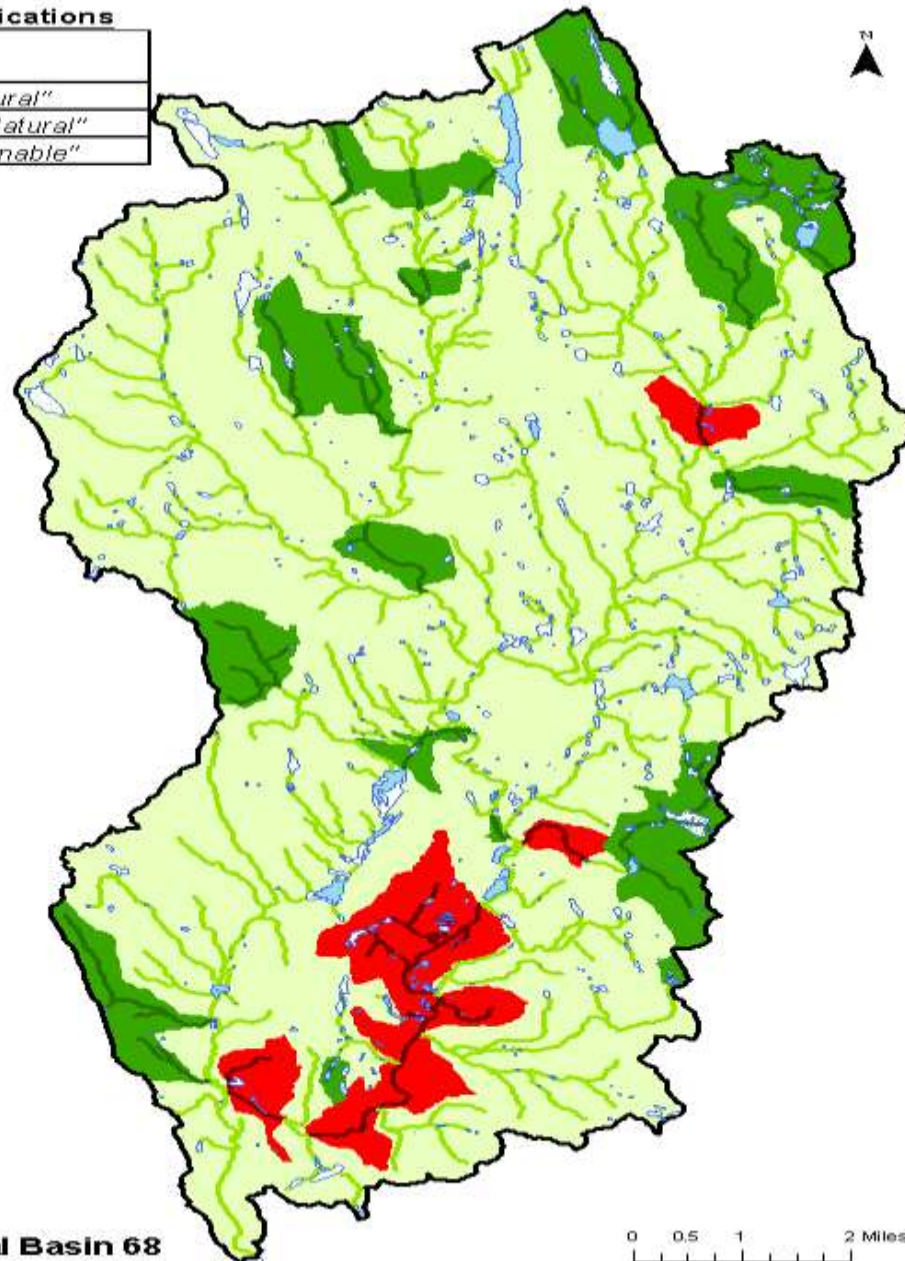
Preliminary Streamflow Classifications Pomperaug Basin

Preliminary Streamflow Classifications

CT HSI	Class	
6-12	Class 1	"Natural"
13 - 30	Class 2	"Near Natural"
31- 60	Class 3	"Sustainable"

Streamflow Classifications

-  Class 1 Streams
-  Class 2 Streams
-  Class 3 Streams
-  Class 1 Basin Area
-  Class 2 Basin Area
-  Class 3 Basin Area



Pomperaug River Regional Basin 68

0 0.5 1 2 Miles

Minimum Flow Release Rule

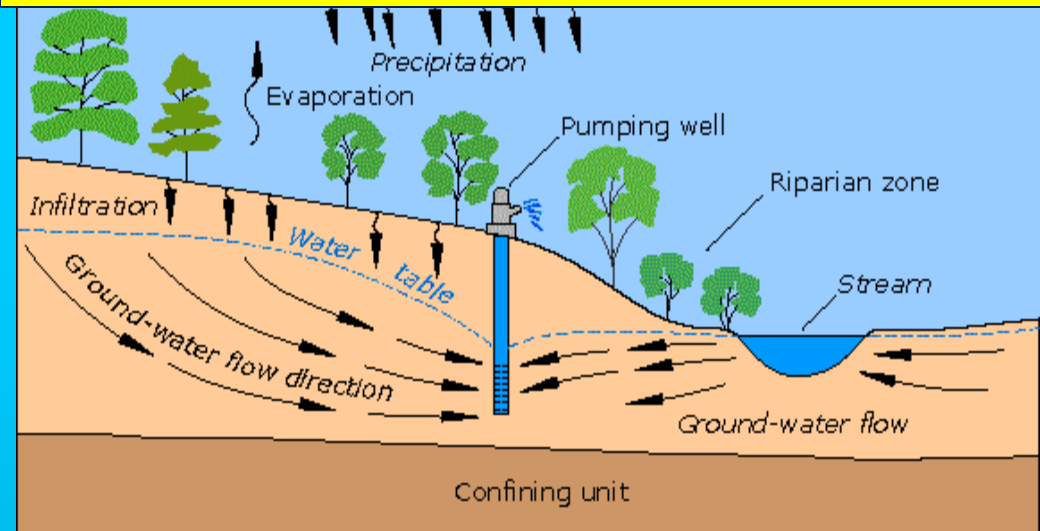


Source - NOAA

Each requires a different approach. Yet there is one underlying premise – accept a certain degree of variation from natural flow – class dependent

Two major ways we influence flow in rivers and streams – dams and direct withdrawals

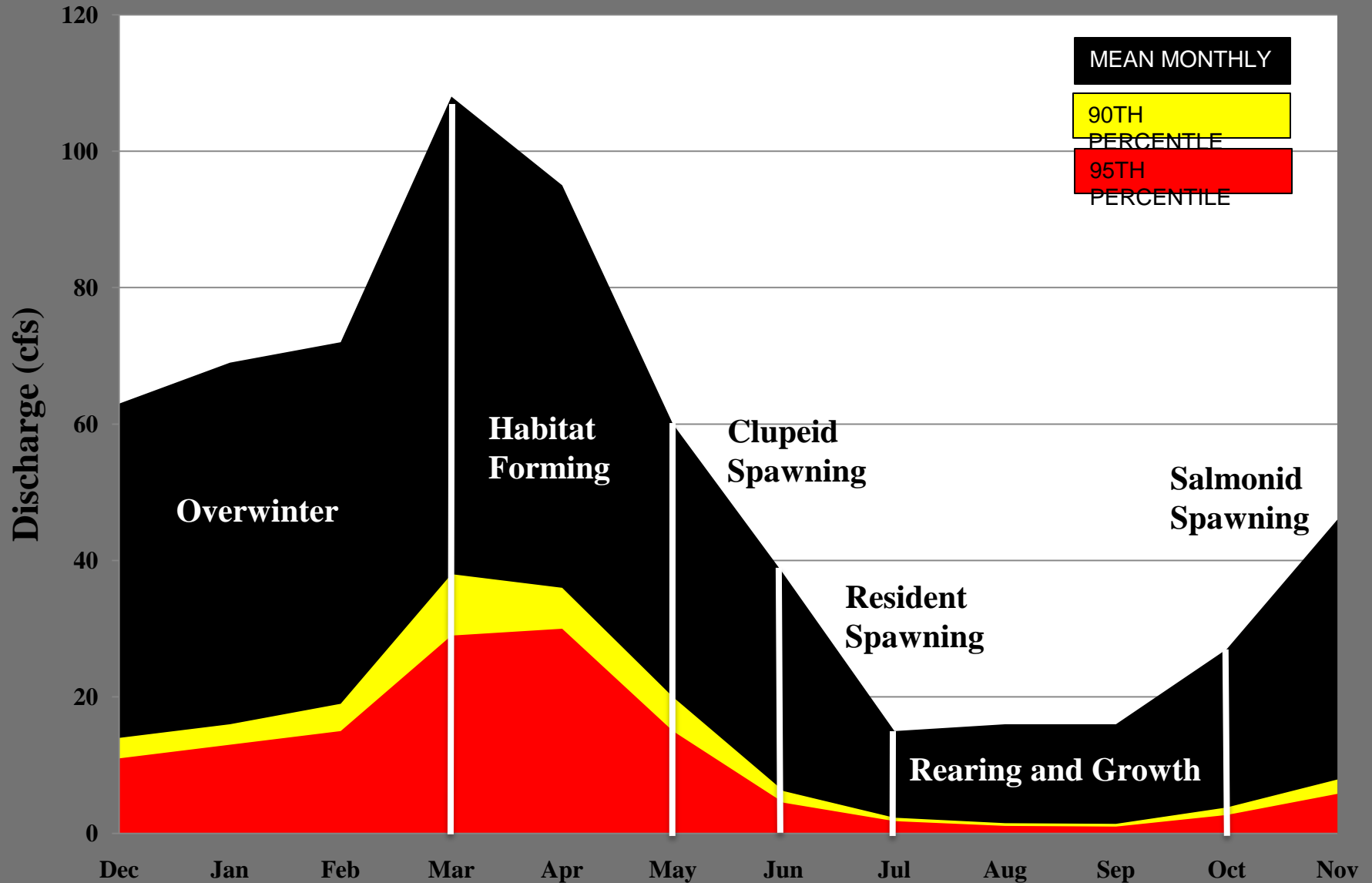
Maximum Flow Reduction Rule



Source - USGS

Mt Hope River

Typical Annual Hydrograph with Six Bioperiods



Regulated Community Action During Five Years Up to Interim Compliance

- Diverters plan, design and build infrastructure to
 - physically make both dry and wet releases
 - measure releases and withdrawals
 - Train staff and install monitoring equipment
 - Develop operational rules to balance sources of supply and maximize yield
 - Implement measures to enhance demand management (conservation) during drought periods

Regulated Community Action During Ten Years Leading Up to Full

• Diverters Compliance

- Evaluate what is necessary to compensate for decline in safe yield as a result of full release
- Steps could include
 - Minimizing leakage/water loss
 - Maximizing effectiveness of demand management
 - Building interconnections to move water
 - Matching water to use – i.e. save potable for drinking
 - Restarting existing supplies
 - Bringing new supplies online
 - Building new treatment as necessary
 - Developing a basin plan



Connecticut Public Act 05-142

Act Concerning the Minimum Water Flow Regulations



	Michigan	Colorado	Connecticut
Driver	Great Lakes Compact, Michigan Public Act 34	HB05-1177 Water for the 21st Century Act	Connecticut Public Act 05-142
Key wording	No adverse resource impact	Non-consumptive water needs	Variable flows, best available science, natural aquatic life
Objective	Withdrawal permitting	Basin planning	Withdrawal permitting, reservoir operation
Legal mechanism for implementation	Restoration: none Protection: DNR, but unresolved for over- allocated rivers	Basin roundtables (stakeholders)	DEP (Can they deny permits?)
Time allotted	2 years (based on 27 years of fish data)	Assessment: 6 years	Set standards: 1 year Implement: 16 years
Available info	Index flow, fish populations	Literature, public datasets	Expert consensus
Current status	WWAT launched and required	Pilot WFET completed	Draft regulations to public comment Oct 13
Next science steps	User-determined	Extend WFET to entire western slope	USGS build hydrologic foundation

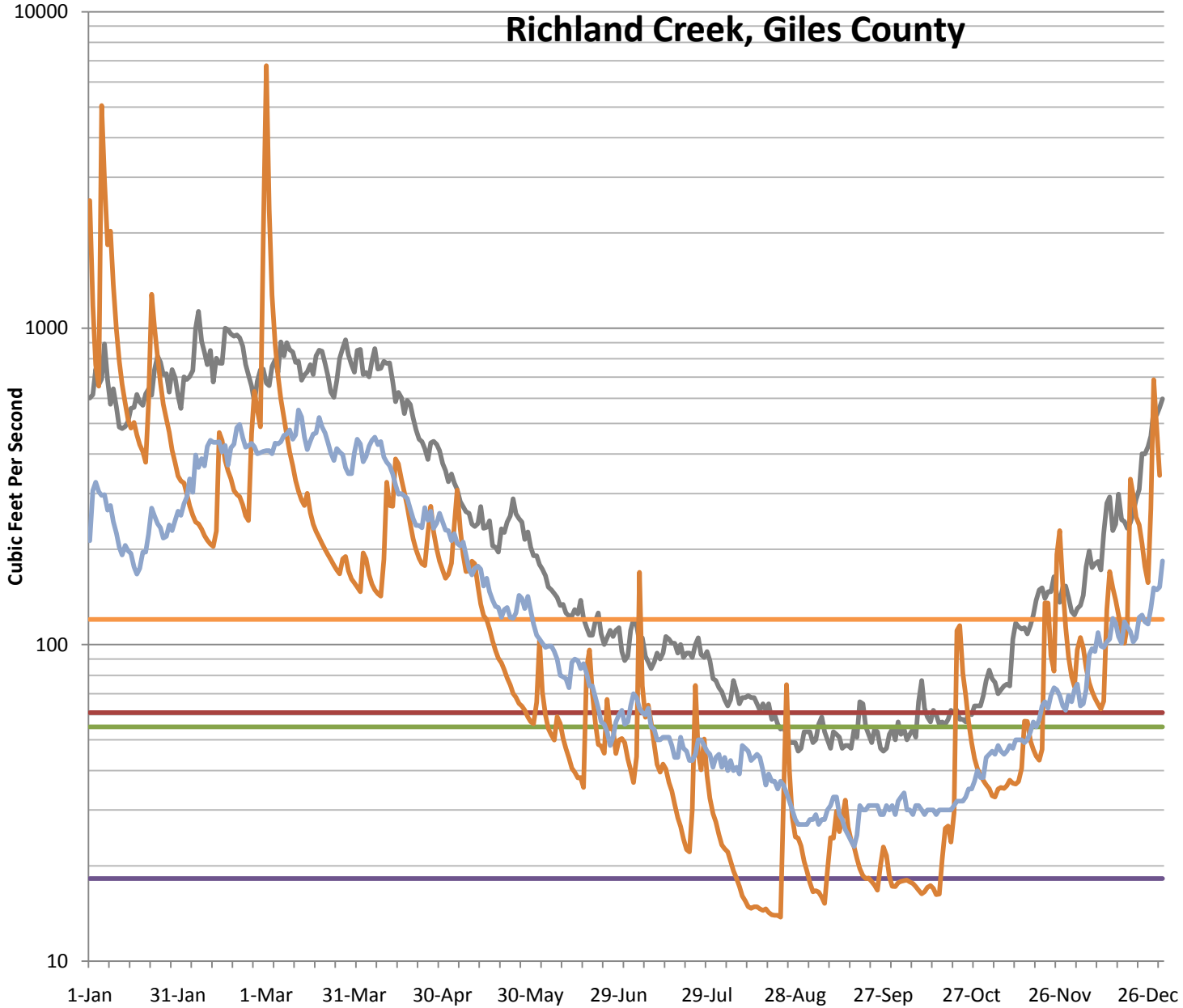
Basic Components of Richland Creek

Water Withdrawal, Giles County

- Utilizes the Stream-Base-Flow-Margin method
 - Stream-Base-Flow-Margin is defined as the difference between a stream's 7Q10 low flow statistic, and the stream's median low flow month of record. The 7Q10 represents extreme low flow conditions (drought), while the September median flow is representative of the stream's base flow or normal low flow conditions which occur in an average year. Most of the stream's flow during this period is groundwater discharge rather than runoff. Therefore, to prevent water withdrawals from turning normal low flow conditions into extreme low flow conditions, water loss from the stream's watershed must not exceed the margin value. As safety factor, especially in ecologically significant areas, only a fraction of the volume may be available for consumptive uses.
- Attributes of the Stream-Base-Flow-Margin Method
 - Ecologically-based approach that protects stream low flows; uses margin between stream low-flow statistics
 - Critical flow regime for aquatic ecology is the lowest monthly median flow (September)
 - Traditional low-flow condition is the lowest flow over 7 consecutive days during a 10 year period (7Q10)
 - The low-flow margin is the September median flow minus the 7Q10
 - The low-flow margin of "Safety" is a % of the margin, less basin water consumptive use (40% in this case). Minimum flow cutoff of 55 cfs
- Non-discretionary controls
- Based on instream ecological needs (boulder darter)
- One withdrawal rate of 6 cfs (16 hour duration)
 - 10 percent of flow when flow is 61 cfs
 - 5 percent of flow when flow is 120 cfs
- Establishes cumulative withdrawal capacity
- What low flow condition results in more than an insignificant lowering of water quality within the ETW reach of Richland Creek?
 - Normal base flow conditions The amount of base flow available to the stream channel varies from month to month and year to year based mainly on the amount and frequency of precipitation. The normal circumstance base flow value for a gauged stream can be determined by plotting the period of record (50 years) median monthly flow values for each month of the year. The median value is used to determine base flow because it is not subject to being skewed by uncommon high flow values as would be the case of using the mean or "average" flow. This analysis will show what month the lowest median flow occurs. In middle Tennessee this is usually September or October. In the case of Richland Creek, the USGS Nashville Office reports this flow occurs in September; providing a base flow of 75.1 cfs at the Pulaski gage.
 - Drought flow conditions (7Q10)
- The status and habitat requirements for the Boulder Darter 66cfs (55cfs at intake)

Site identification	Richland Creek (mile)	Median Sept. Flow (cfs)	7Q10 (cfs)	Low	Available for Use ¹ (cfs)	Cutoff Flow ² (cfs)	Consumptive Withdrawal (cfs)	Cumulative Withdrawal (cfs)	Watershed Area (sq. miles)	Antideg Status
				Flow Margin (cfs)						
USGS Gage (mile 30)	30	75.1 ³	17.3	58	23	52			366	Tier I
Hillcrest Country Club	29						0.023 ⁵	0.023		Tier I
Pulaski Water Plant (mile 24.1)	24						6.8 ⁵	6.8		Tier I
Richland STP (23.3)	23						-1.2	5.6		Tier I
irrigation withdrawal (mile 19.2)	19						3.1 ⁶	8.7		Tier I
Proposed Intake	13							8.7		Tier I
Aspen Hill Bridge	12	79.1 ⁴	18.21	61	24	55	5.8	14.5	421	Tier I
irrigation withdrawal (mile 7.3)	7						3.3 ⁶	17.8		Tier I
Silver Creek (mile 4.8)	5	105.1 ⁴	24.2	81	32	73		17.8	480	ETW
Vinta Mill Dam (mile 4.25)	4							17.8		ETW
irrigation withdrawal (mile 1.5)	2						2.3 ⁶	20.1		ETW
irrigation withdrawal (mile 0.9)	1						2.9 ⁶	23.0		ETW
Elk River	0	106.4 ⁴	24.5	82	33	74		23.0	488	ETW

Richland Creek, Giles County



- median flow (50 percentile of daily values)
- 120 cfs, flow below which withdrawal = > 5%
- 61 cfs, flow below which withdrawal = > 10%
- no withdrawal under 55cfs
- 7Q10, 18.21 cfs
- 2007
- 20 percentile

STATE-BY-STATE BREAK-OUT

- **Current Standard** (e.g., 7Q10, Tennant)
- **Driver** (e.g., law, event, agency; key wording)
- **Implementation** (e.g., withdrawal permitting, dam relicensing, water supply planning)
- **Opportunities and Constraints** (e.g., timeline; available information, resources, and capacity)
- **Current Activities** (e.g., research, coalition building)
- **3-5 Year Vision** (e.g., interim standard or steps)
- **Long-Term Vision**

