

Sustainable Rivers and Streams



Finding the Balance between Human and Ecological Needs for Water



Stream flow History

1971

PA-229

1979

Minimum Stream Flow
Regulation Adopted

1982

Diversion Act

2002

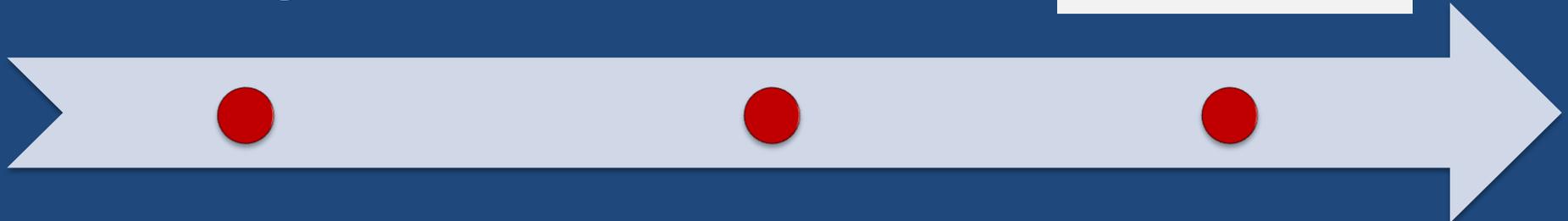
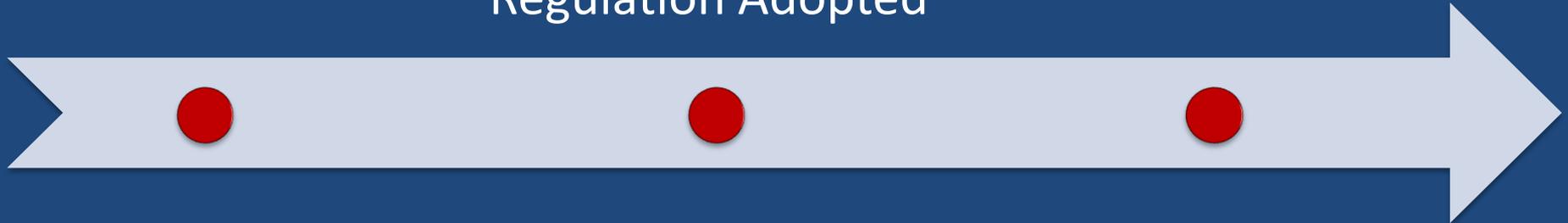
Waterbury v.
Washington

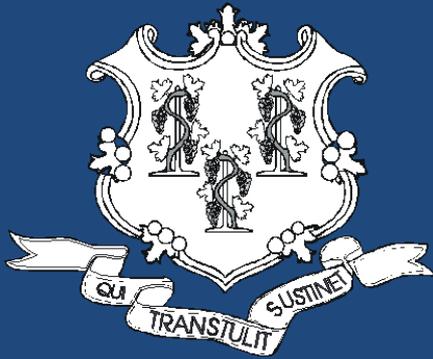
2003

Program Review

2005

PA 05-142



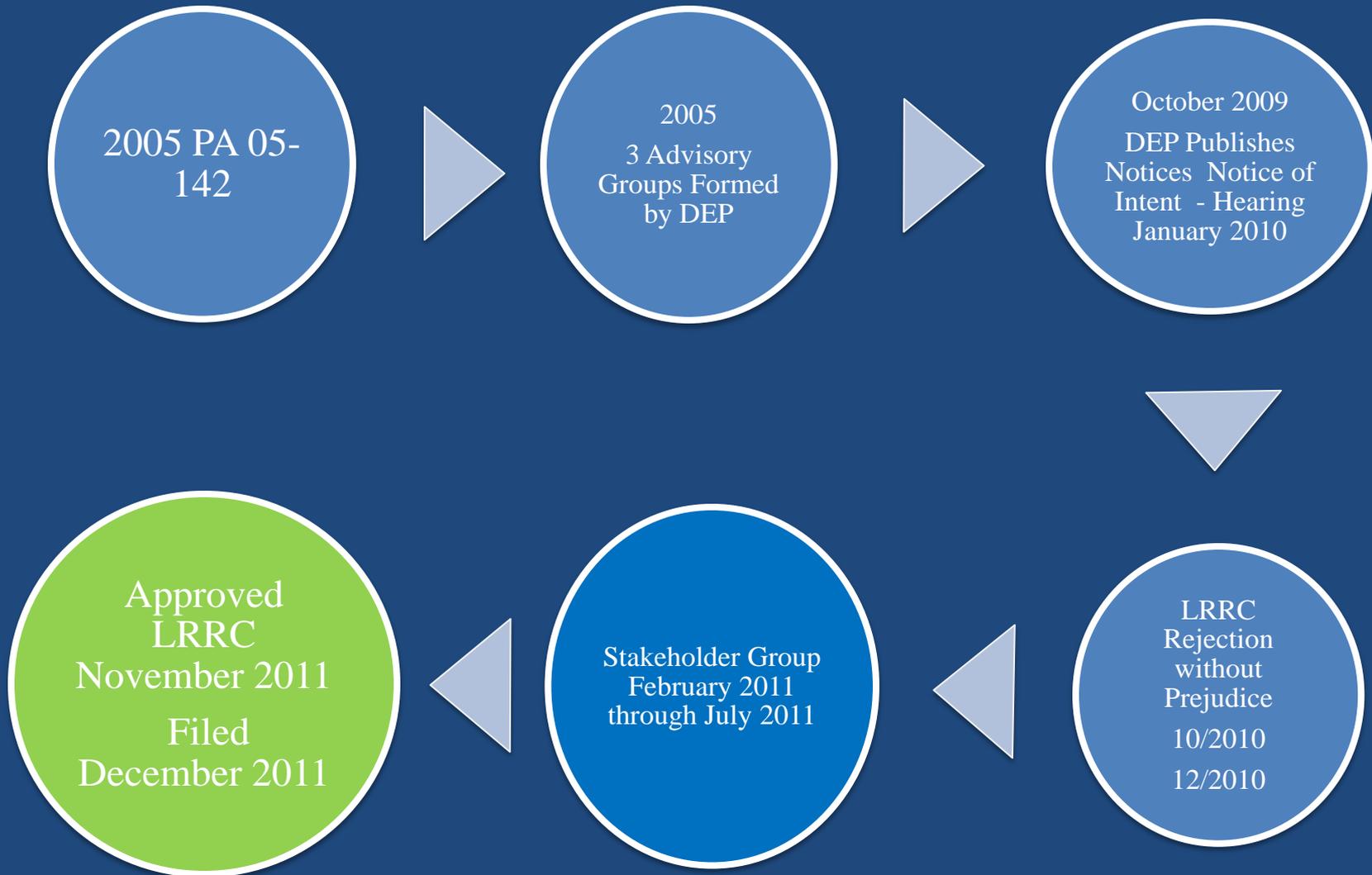


Public Act No. 05-142
AN ACT CONCERNING
THE MINIMUM WATER FLOW REGULATIONS

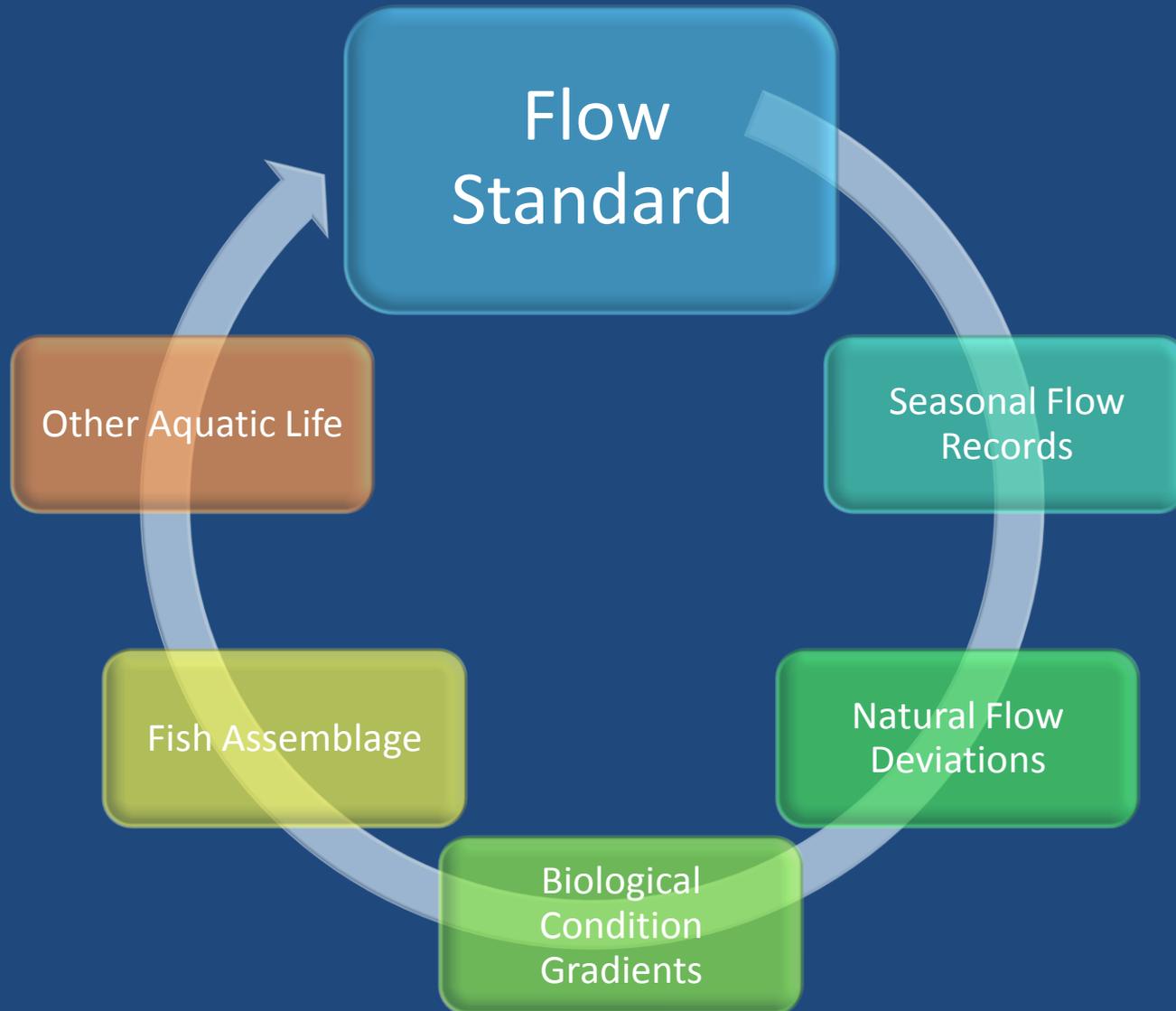
DEP Commissioner shall adopt regulations for stream flow that...

- apply to all rivers and streams
- based on best available science
- provide for the needs and requirements of public health, flood control, industry, public utilities, water supply, public safety, agriculture and other lawful uses of such waters and further recognizing and providing for stream and river ecology, the requirements of natural aquatic life, natural wildlife and public recreation, and after considering the natural flow of water

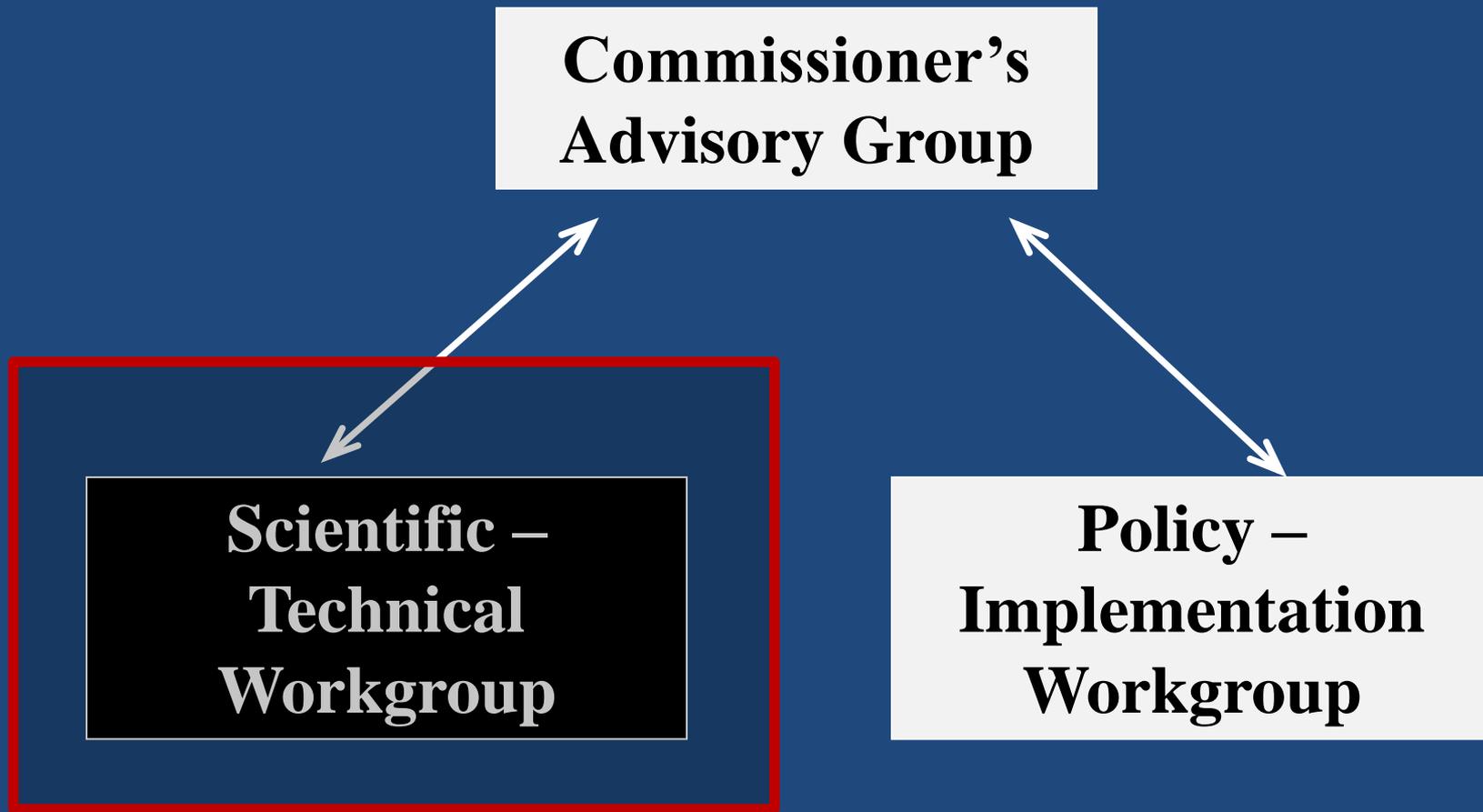
Public Process



Best Available Science



The Path Towards the Stream Flow Regulation



- Broad Group of Stakeholders including other state agencies, USGS, USEPA, Nature Conservancy, Trout Unlimited, Rivers Alliance, Water Utilities, and Universities

Scientific –Technical Committee

Hydrogeologists



Committee consisted of
a diverse group of
scientists from multiple
backgrounds

Geomorphologists



Water Resource Engineers



Stream Ecologists



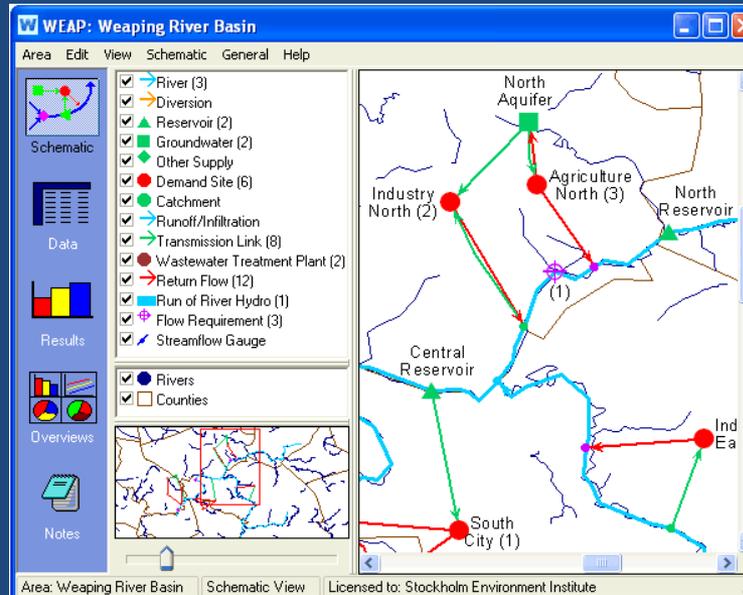
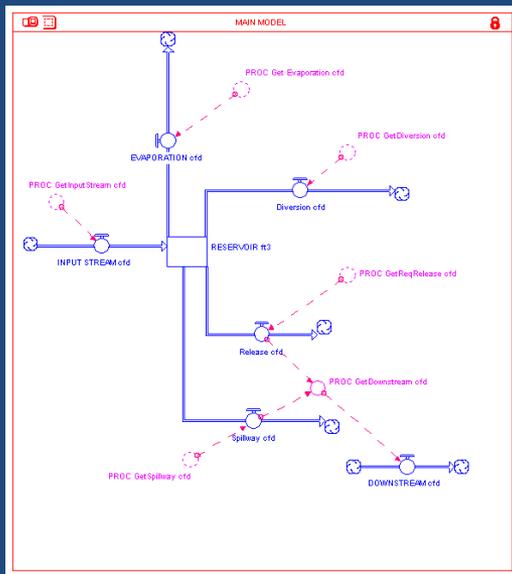
Fisheries Biologists



Scientific – Technical Committee

What It Takes to Develop Stream flow Standards...

- 24 Meetings (January 2006 – December 2008)
- > 140 Meeting Hours
- 2,126 Model Runs
- 1,000 Cheese Cubes



Fish Assemblage Responses to Water Withdrawals and Water Supply Reservoirs in Piedmont Streams

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10-13 show the stream's mean daily base flow (mean flow base [MFB]) and were related directly downstream after being a water withdrawal or from a withdrawal taken from an unimpounded reach. Ordinal analysis of catch data showed a significant negative correlation of reservoir size corresponding to decreases in habitat generalists. However, these species decreased from about 30% to 10% of the total catch, and also declined as potential withdrawal size increased from about 0.5 to one TGD equivalent of water. Reservoir presence was correlated with, along with drainage area, ac-

Evaluating Effects of Water Withdrawals and Impoundments on Fish Assemblages in Connecticut Streams

Jason C. Vokoun
and
Yoichiro Kanno

The Natural Flow Regime

A paradigm for river conservation and restoration

N. LeRoy Poff, J. David Allan, Mark B. Bain, James R. Karr, Karen B. Prestegard, Brian D. Richter, Richard E. Sparks, and Julie C. Stromberg

Humans have long been fascinated by the dynamics of free-flowing water. Yet we have expended great effort to tame rivers for transportation, water supply, flood control, agriculture, and power generation. It is now recognized that harnessing of streams and rivers comes at great cost. Many rivers no longer support socially valued and native species or sustain healthy ecosystems that provide important goods and services (Dainoff et al. 1995, NRC 1992).

N. LeRoy Poff is an assistant professor in the Department of Biology, Colorado State University, Fort Collins, CO 80523-1878 and formerly senior scientist at Trout Unlimited, Arlington, VA 22209.

J. David Allan is a professor at the School of Natural Resources, K. E. Broome, Michigan State University, East Lansing, MI 48824-1315. Mark B. Bain is a research scientist and associate professor at the New York State College of Environmental Science and Forestry, Syracuse, NY 13210. James R. Karr is a senior research scientist at the Department of Natural Resources, Cornell University, Ithaca, NY 14853-1501. Brian D. Richter is a professor at the Department of Fisheries and Zoology, Box 37980, University of Richmond, Virginia, VA 23170-7980. Karen B. Prestegard is an associate professor at the Department of Geology, University of Maryland, College Park, MD 20742. Bruce D. Richter is retired by the Department of Energy, Environment, and Planning, The Nature Conservancy, Hayden, CO 81026. Richard E. Sparks is director of the River Research Laboratories at the Illinois Natural History Survey, Urbana, IL 62904. Julie C. Stromberg is an associate professor at the Department of Environmental and Atmospheric Sciences, Tufts University, Medford, MA 02155. © 1997 American Institute of Biological Sciences.

However, current management approaches often fail to recognize the fundamental principle that the integrity of flowing water systems depends largely on their natural dynamic character; as a result, these methods frequently prevent successful river conservation or restoration. Streamflow quantity and timing are critical components of water quality, and the ecological integrity of river systems is affected, streamflow, which is strongly correlated with many critical physical characteristics of rivers, such as water temperature, channel geomorphology, and habitat diversity, can be considered a "master variable" that limits the distribution and abundance of riverine organisms (Pusey et al. 1995, Rosh et al. 1988). Until recently, however, the importance of natural streamflow variability to sustaining healthy aquatic ecosystems has been virtually ignored.

Historically, the "protection" of river ecosystems has been limited in scope, emphasizing water quality and minimum flow. Water resources management has also suffered from the often-incomplete perspectives and fragmented responsibilities of agencies of Engineers and Surveyors of Civil Engineers and Surveyors of the Army Corps of Engineers and Bureau of Reclamation. The National Water Research Institute, the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency require that conservation and management actions be firmly grounded in scientific understand-

December 1997

769

Defining Important Stream Flows for Connecticut

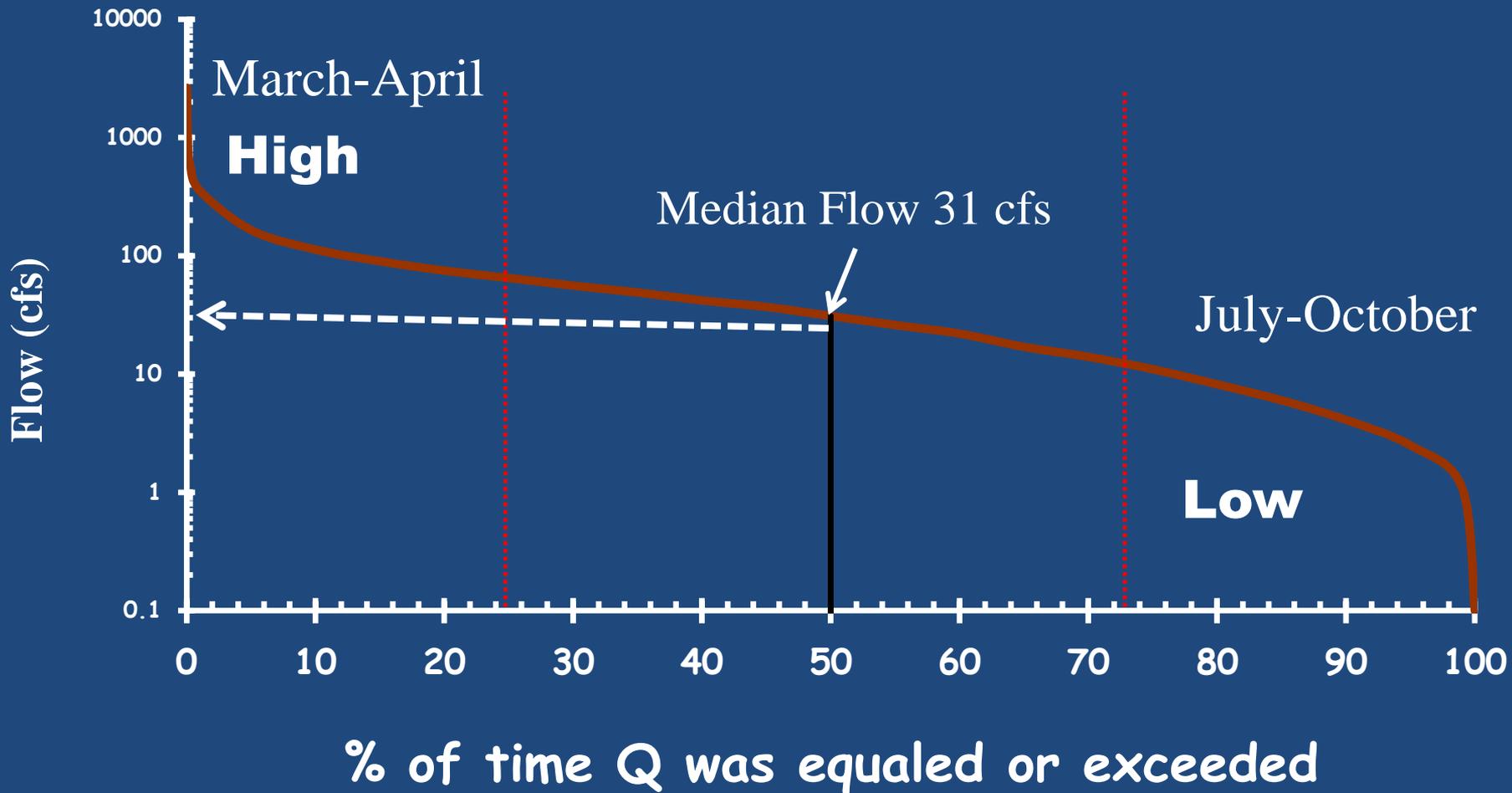
1. Natural Hydrograph is Important !

- The more water that is used for human uses, the more the hydrograph is altered
- The more the hydrograph is altered, the more it impacts aquatic life

2. Bioperiods- seasonal flow variation linked to biological processes

3. Biological Condition Gradient as Unifying Theme

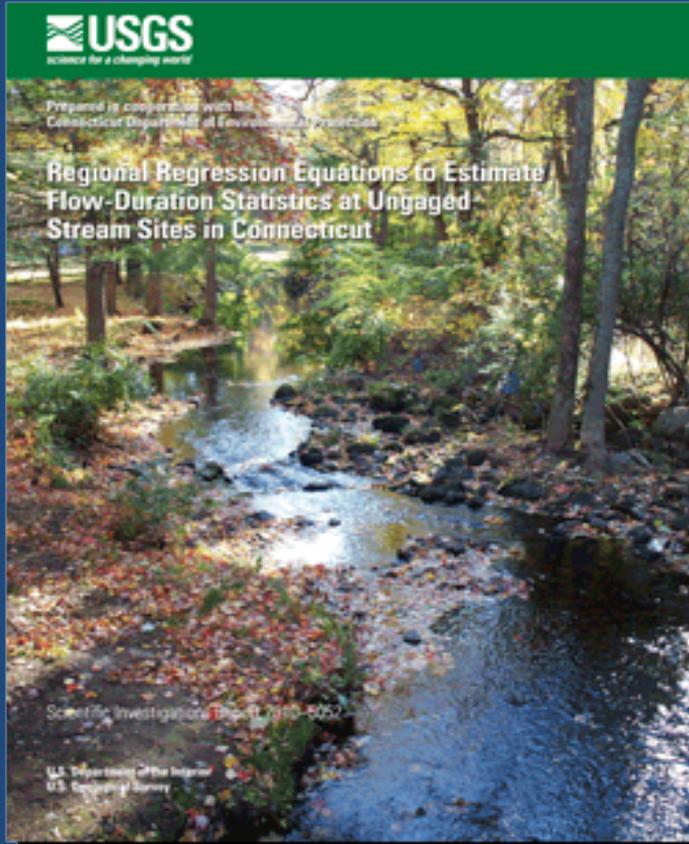
Natural Variation in Stream Flow



High Flow

Low Flow

StreamStats



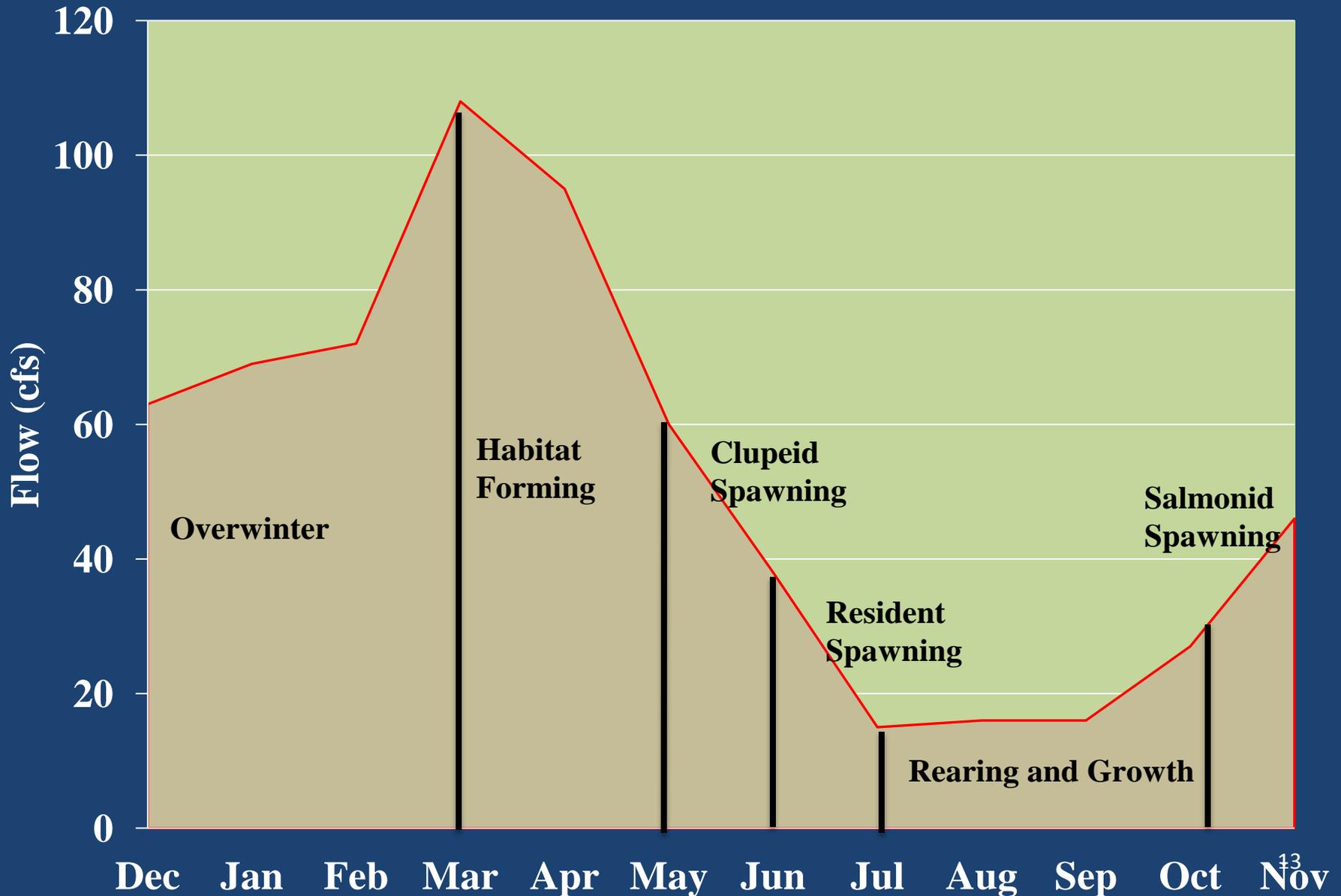
The screenshot shows the USGS StreamStats website for Connecticut. The browser title is 'USGS StreamStats - Windows Internet Explorer' and the URL is 'http://streamstats.srs.usgs.gov/ct_ss/default.aspx?stabbr=ct&dt=1316112001068'. The page features the USGS logo and the title 'Connecticut StreamStats'. There is a toolbar with various navigation and map tools, and a 'Zoom To' dropdown set to '1:1,334,000'. The main content is a map of Connecticut with a cyan-colored stream network overlaid. On the left side, there are three panels: 'Results' (empty), 'Map Contents' (showing 'CT@ct_ss' checked), and 'Navigation' (with a compass rose). At the bottom, there are links for 'Accessibility', 'FOIA', 'Privacy', and 'Policies and Notices'. The footer includes 'U.S. Department of the Interior | U.S. Geological Survey', the URL 'http://streamstats.srs.usgs.gov/ct_ss/default.aspx', 'Page Contact Information: StreamStats Help', 'Page Last Modified: 09/15/2011 14:40:02', 'Streamstats Status', 'News', 'USA.gov', and 'TAKE PRIDE IN AMERICA'. The zoom level is set to 125%.

USGS StreamStats Website

<http://water.usgs.gov/osw/streamstats/connecticut.html>

Example of Natural Hydrograph

Mt Hope River Annual Hydrograph with Six Bioperiods



Diversions that Impact Streamflow

Dam Release Rule

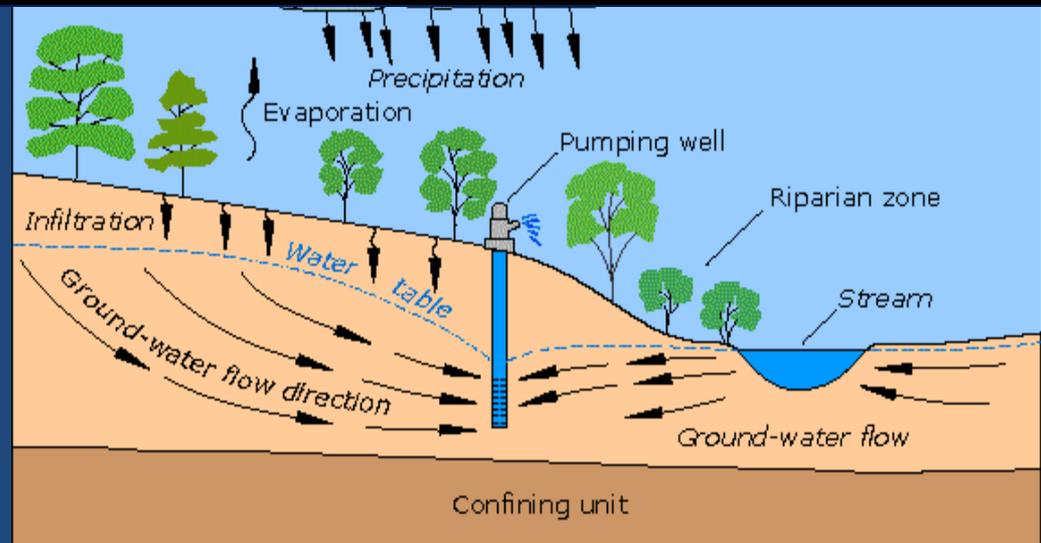


Source - DEP

Each requires a different approach - degree of variation from natural flow is class dependent

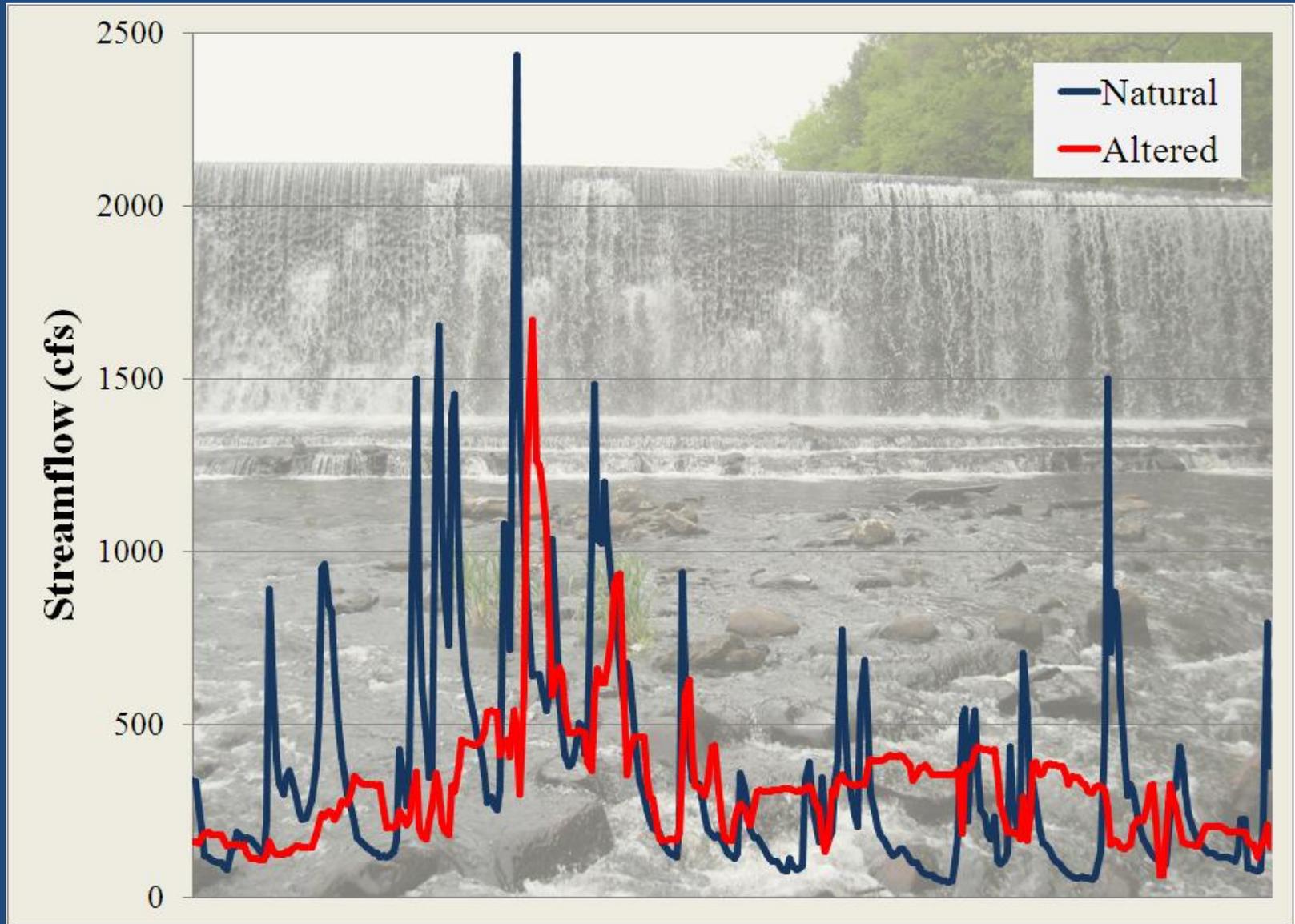
Two major ways we influence flow in rivers and streams – dams with storage and other withdrawals (wells, pumps, siphons, channels, water intake etc)

Other Structure



Source - USGS

Humans Alter the Natural Hydrograph

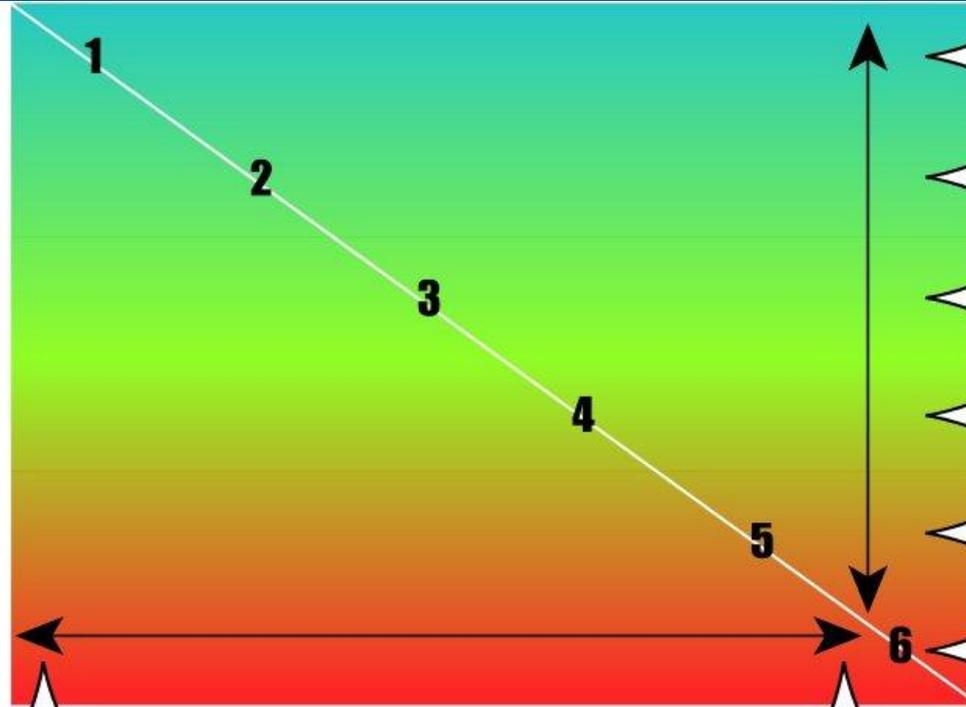


Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov

Biological Condition Gradient

Biological Integrity

Natural



1 Natural structural, functional, and taxonomic integrity is preserved.

2 Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

3 Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained.

4 Moderate changes in structure due to replacement of sensitive ubiquitous taxa by more tolerant taxa; ecosystem functions largely maintained.

5 Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.

6 Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.

Watershed, habitat, flow regime and water chemistry as naturally occurs.

Chemistry, habitat, and/or flow regime severely altered from natural conditions.

Degraded

Biological Condition Gradient

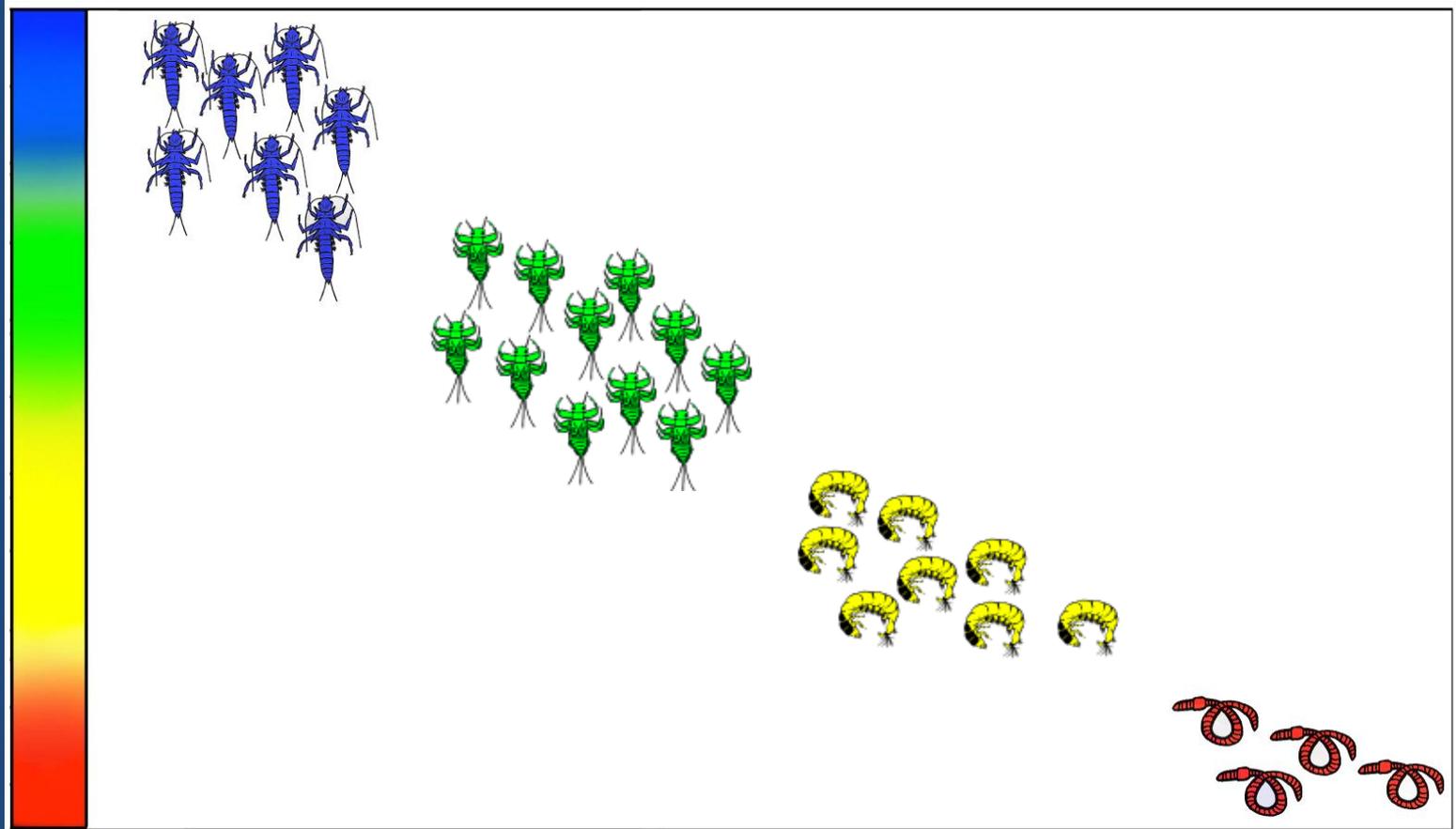
Biological Integrity

Natural

Fair

Poor

Degraded



Low

Moderate

High

Level of Stress

Biological Condition Gradient

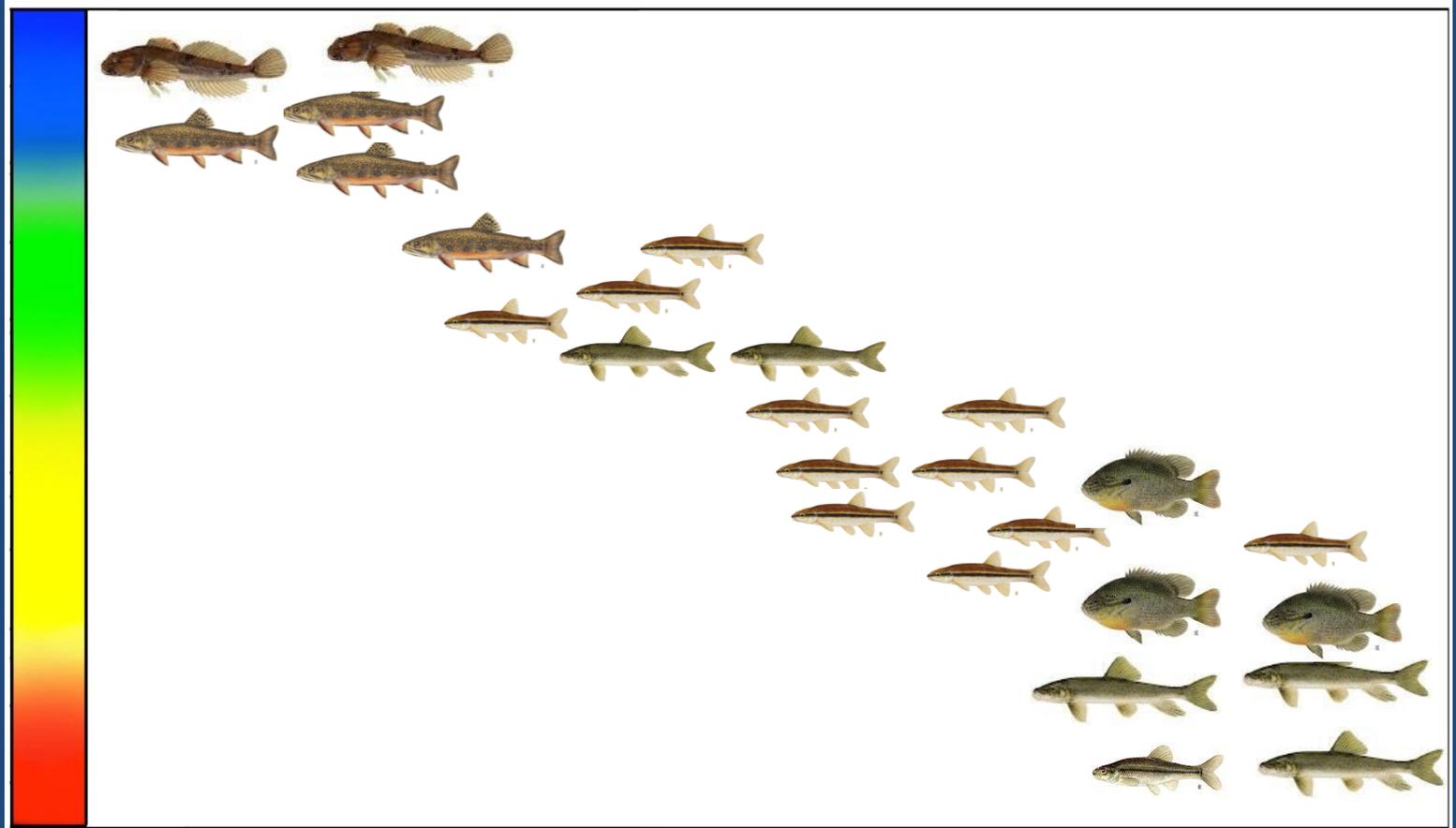
Biological Integrity

Natural

Fair

Poor

Degraded



Low

Moderate

High

Level of Stress

Biological Condition Gradient

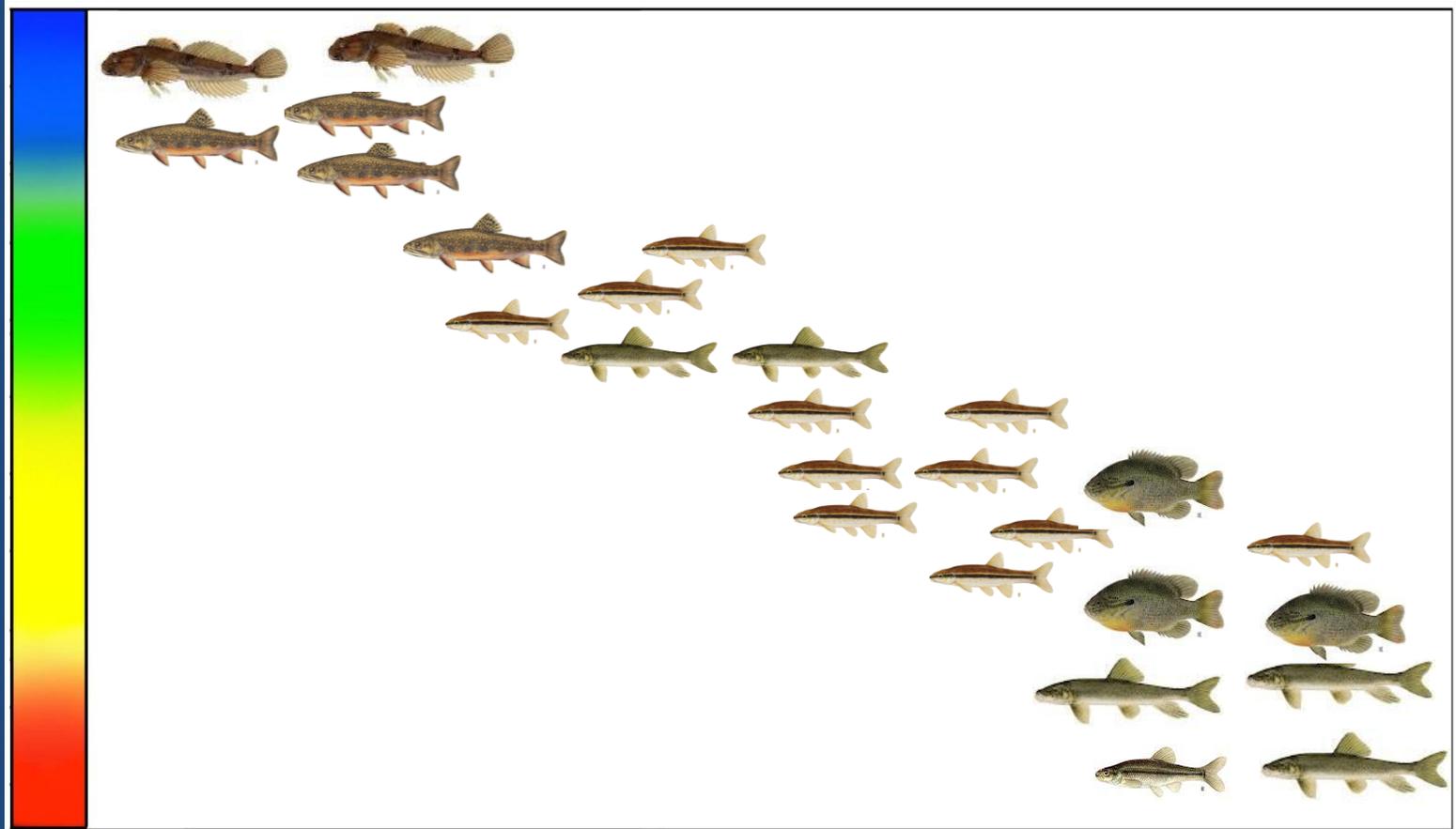
Biological Integrity

Natural

Fair

Poor

Degraded



Low

Moderate

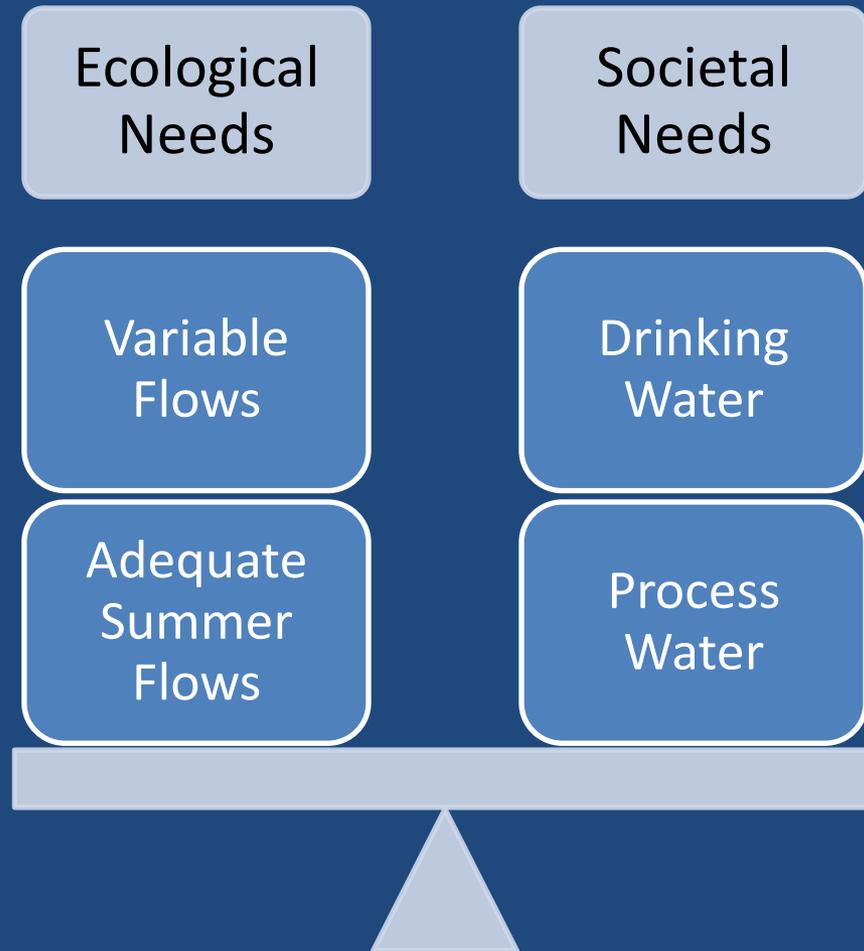
High

Alteration of Natural Hydrograph

Integrating the Information

- Not all streams and rivers in the state are the same
- Not possible to take everything back to pristine
- Need variability to incorporate seasonal flow patterns and bioperiods with human needs
- Challenge is to define:
 - Who needs to comply
 - What is needed where
 - When
 - variability needed
 - full compliance

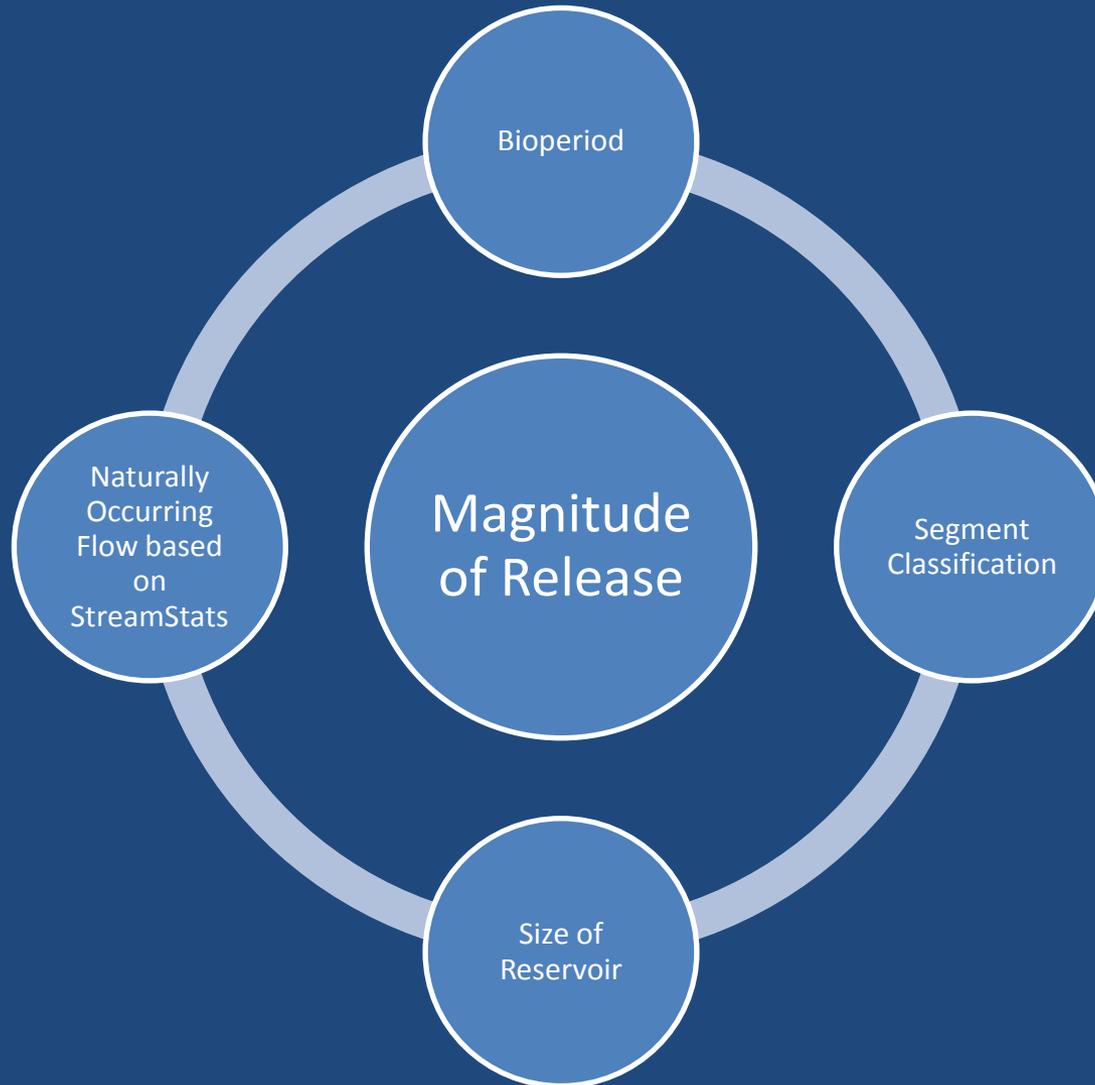
Challenge is to Balance:



What is Regulated?

- Downstream releases from dams with an authorized consumptive diversion behind the dam

What is Release Requirement?

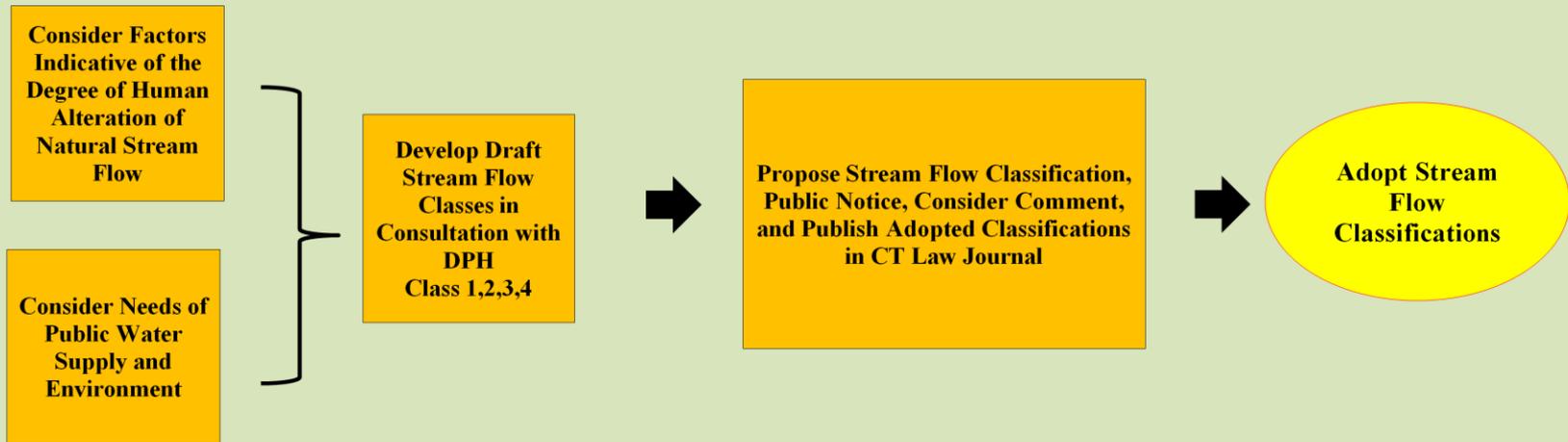


Framework of the Regulations

- Title
- Definitions
- Applicability
- Narrative standards
- Adoption of stream system classifications
- Release requirements
- Record keeping and reporting
- Conflict and severance

Adopted Stream Flow Regulations - December 2011

Stream Flow Classification Process *



* any classification changes or petition to change follows a similar public process

Compliance 10 Years Post Classification

Full Release	Minimum Release Provisions	Special Compliance Provisions																														
<p>Class 1 - Free-flowing Class 2 - Release 75% of Natural Inflow Class 3 - Release According to Rule Below:</p> <table border="1"> <thead> <tr> <th rowspan="2">Bioperiod</th> <th rowspan="2">Effective Dates</th> <th colspan="2">Minimum Required Release</th> </tr> <tr> <th>Antecedent Period Dry</th> <th>Antecedent Period Wet</th> </tr> </thead> <tbody> <tr> <td>Overwinter</td> <td>Dec 1- Feb 28/29</td> <td colspan="2">Bioperiod Q99</td> </tr> <tr> <td>Habitat Forming</td> <td>Mar 1 - Apr 30</td> <td colspan="2">Bioperiod Q99</td> </tr> <tr> <td>Clupeid Spawning</td> <td>May 1 - May 31</td> <td colspan="2">Bioperiod Q95</td> </tr> <tr> <td>Resident Spawning</td> <td>June 1 - June 30</td> <td colspan="2">Bioperiod Q90</td> </tr> <tr> <td>Rearing and Growth</td> <td>July 1- Oct 31</td> <td>Bioperiod Q80</td> <td>Bioperiod Q50</td> </tr> <tr> <td>Salmonid Spawning</td> <td>Nov 1 - Nov 30</td> <td colspan="2">Bioperiod Q90</td> </tr> </tbody> </table> <p>Class 4 - Class 4 Narrative Streamflow Standards with goal of Class 3 to maximum extent practicable through approved site specific release</p>	Bioperiod	Effective Dates	Minimum Required Release		Antecedent Period Dry	Antecedent Period Wet	Overwinter	Dec 1- Feb 28/29	Bioperiod Q99		Habitat Forming	Mar 1 - Apr 30	Bioperiod Q99		Clupeid Spawning	May 1 - May 31	Bioperiod Q95		Resident Spawning	June 1 - June 30	Bioperiod Q90		Rearing and Growth	July 1- Oct 31	Bioperiod Q80	Bioperiod Q50	Salmonid Spawning	Nov 1 - Nov 30	Bioperiod Q90		<p>Dams with Watersheds < 3 square miles, Reservoirs in Series, Reservoirs with Usable Storage < 100 MG</p> <p><i>Release Rearing and Growth Bioperiod Q80 or Natural Inflow, whichever is less</i></p>	<p>Spring Storage Preservation, Can Reduce Releases Consistent with Water Supply Plan Triggers under Drought Conditions, Maintaining Margin Of Safety</p> <p><i>At no time shall Release be less than Rearing and Growth Bioperiod Q80 or Natural Inflow, whichever is less</i></p>
Bioperiod			Effective Dates	Minimum Required Release																												
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Other Options	Short-term Variance Procedures, Site Specific Release including Class 4																															
Exemptions (some subject to conditions)	Include Hydropower under FERC, Large Tidal Rivers, Dams without Consumptive Diversions, Permitted Diversions, Public Safety Withdrawals, Diversions for Agriculture and Golf Courses, Flood Control Dams, others																															

Key Points Regarding Applicability

- If release required under 1979 regulations – must continue until new release required
- Exemptions
 - Permitted diversions
 - FERC regulated dams
 - Flood control dams
 - Recreational impoundments
 - Dams discharging to tidal rivers
 - Dams with small watersheds and/or naturally small flows

Narrative Stream Flow Standards

Biological Integrity

Natural

1 Natural Flow Condition – Rivers for River Fish

2 Minimal Alteration of Flow – Rivers for some River Fish

3 Moderate Alteration – Rivers for some Fish – water for many uses

Substantially altered – maintain Class 3 flows to maximum extent practicable

4

Degraded

Low

Alteration of Hydrograph

High

Procedures to Classify Waters

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

Consider Needs of Public Water Supply and Environment



Develop Draft Stream Flow Classes in Consultation with DPH Class 1,2,3,4



Propose Stream Flow Classification, Public Notice, Consider Comment, and Publish Adopted Classifications in CT Law Journal



Adopt Stream Flow Classifications

GIS Data Layers

- Diversions
- Dams
- Impervious Cover
- Return Flow
- Unique Factors



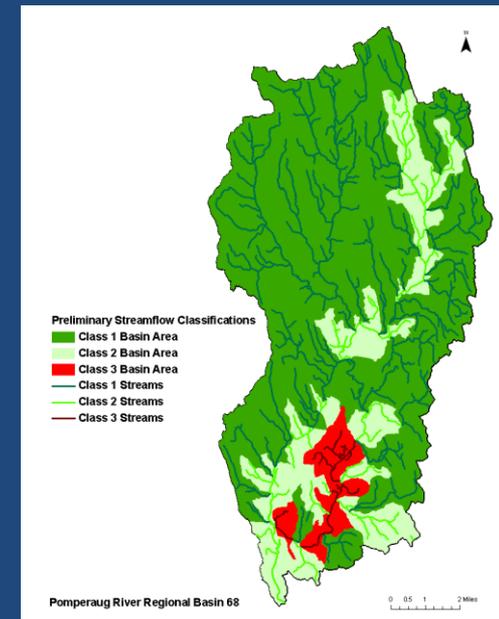
- Water Supply MOS
- Wild and Scenic Rivers
- Anadromous fish, and other plants and animals and others



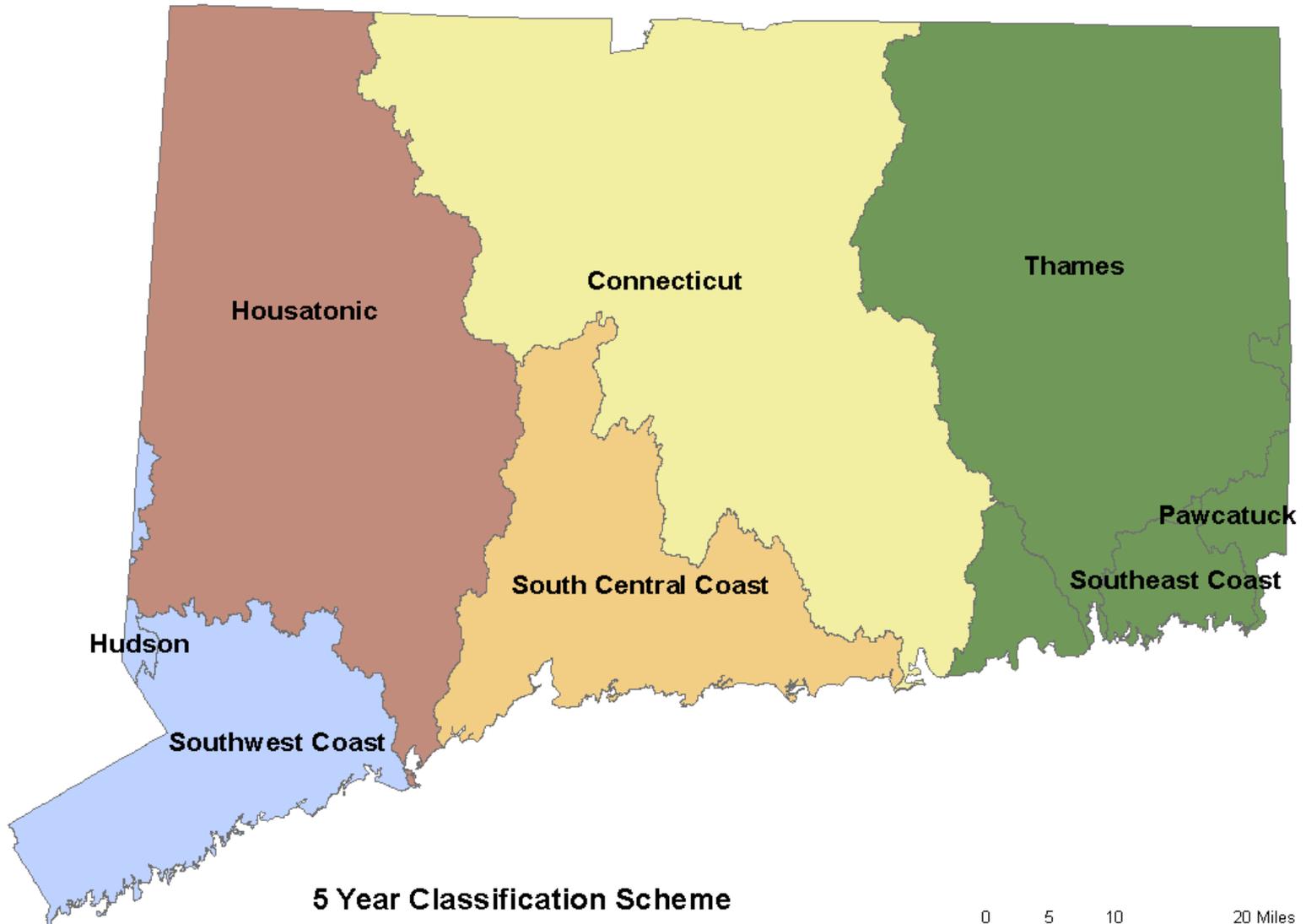
Public Process



Stream Flow Classes



Procedures to Classify Waters



Implementation Timeframe



Classification

Release Required
10 years post-
classification

Basic Class 3 Release Rule

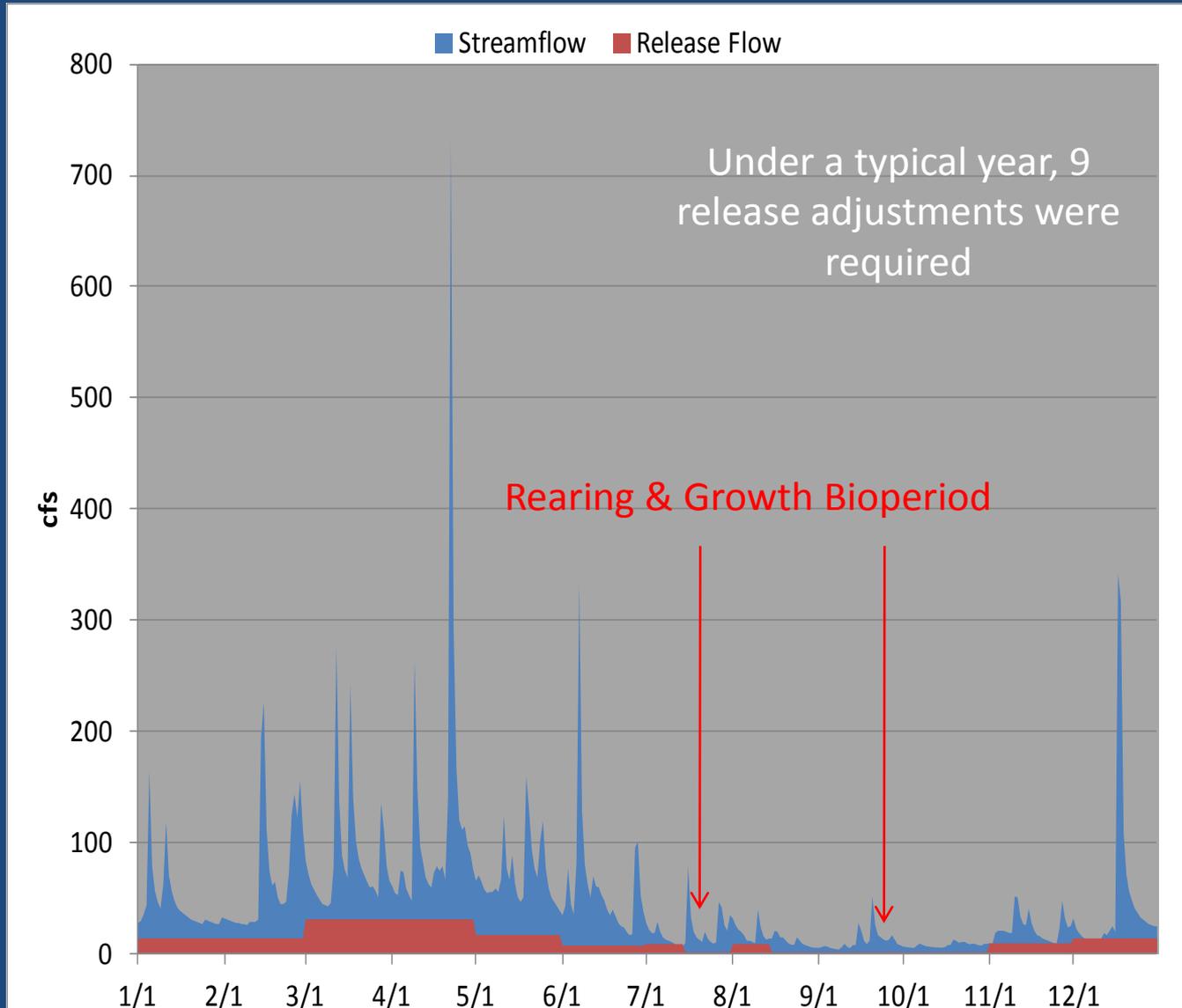


Multi Release Rule

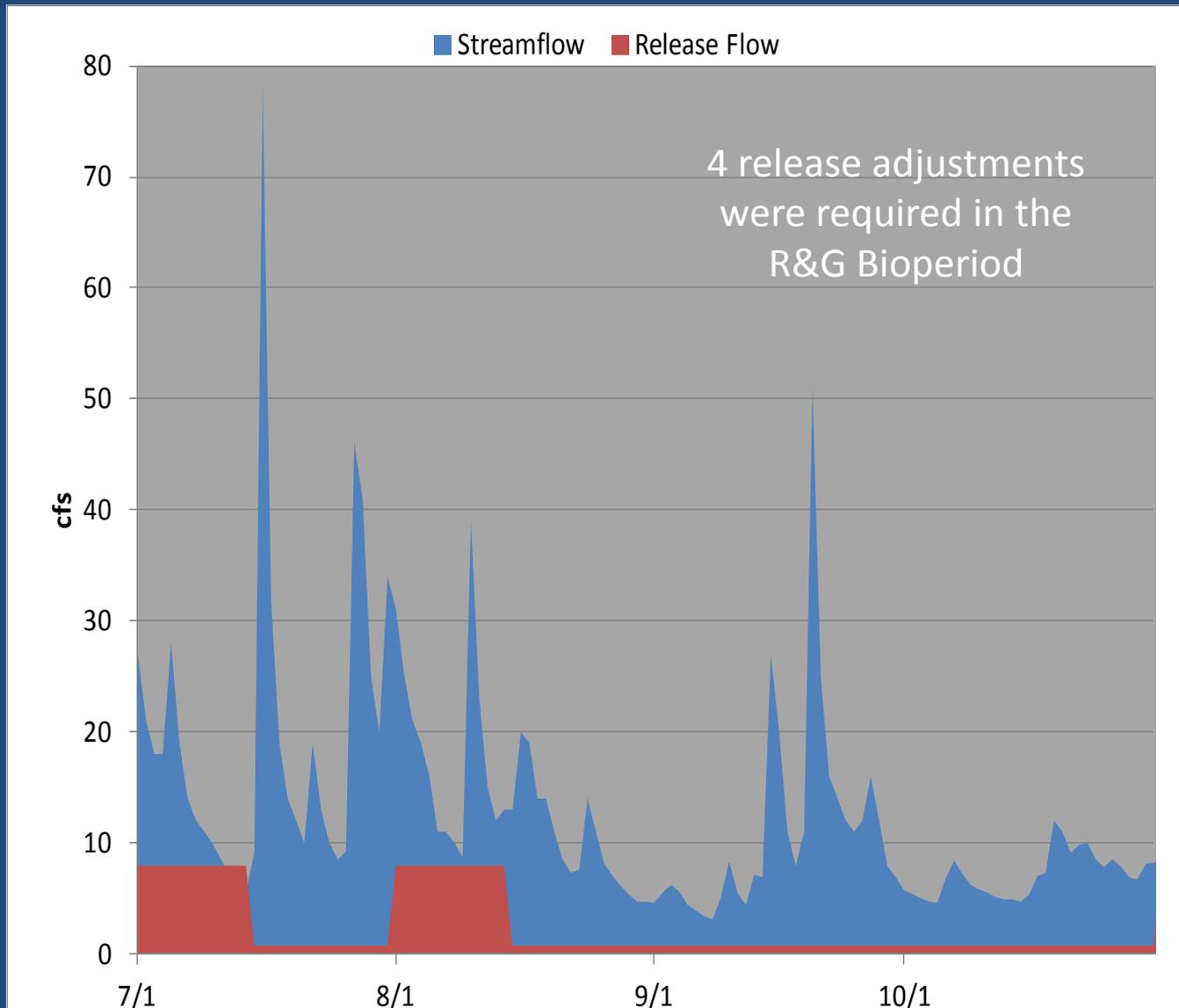
Bioperiod	Effective Dates	Minimum Required Release	
		Antecedent Period Dry	Antecedent Period Wet
Overwinter	Dec 1- Feb 28/29	Bioperiod Q99*	
Habitat Forming	Mar 1 – Apr 30	Bioperiod Q99	
Clupeid Spawning	May 1 – May 31	Bioperiod Q95	
Resident Spawning	June 1 – June 30	Bioperiod Q90	
Rearing and Growth	July 1- Oct 31	Bioperiod Q80	Bioperiod Q50
Salmonid Spawning	Nov 1 – Nov 30	Bioperiod Q90	

* Established by Stream Stats

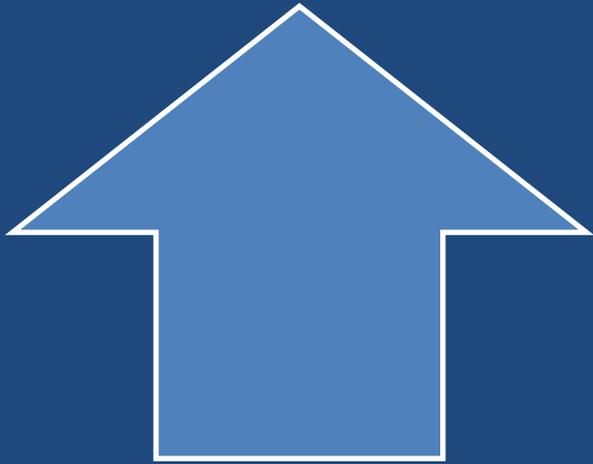
Variable Release Rule



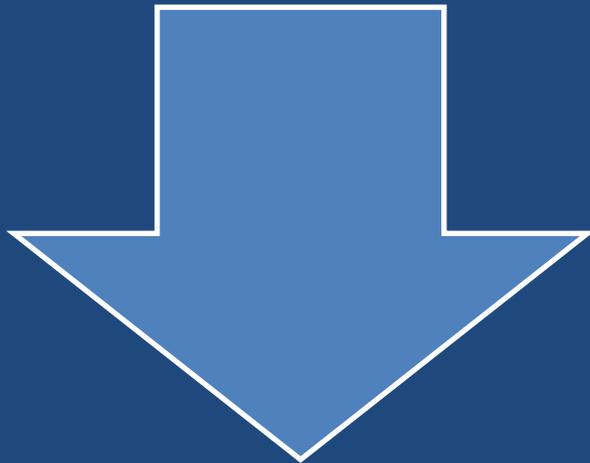
Rearing & Growth Bioperiod



Key Tension Point



Full Releases



Adequate Water
for Suppliers

Release Rule Off Ramps



Reservoirs Subject to Multi Level Release Rule

Compliance Flexibility

Self Implementing Based on Ambient Condition

Reduce Spring Releases to 85 % to Preserve Storage

Drought Off Ramps

Self Implementing

Reduce Release up to 50% * or as necessary to Preserve MOS
(For 10 years)

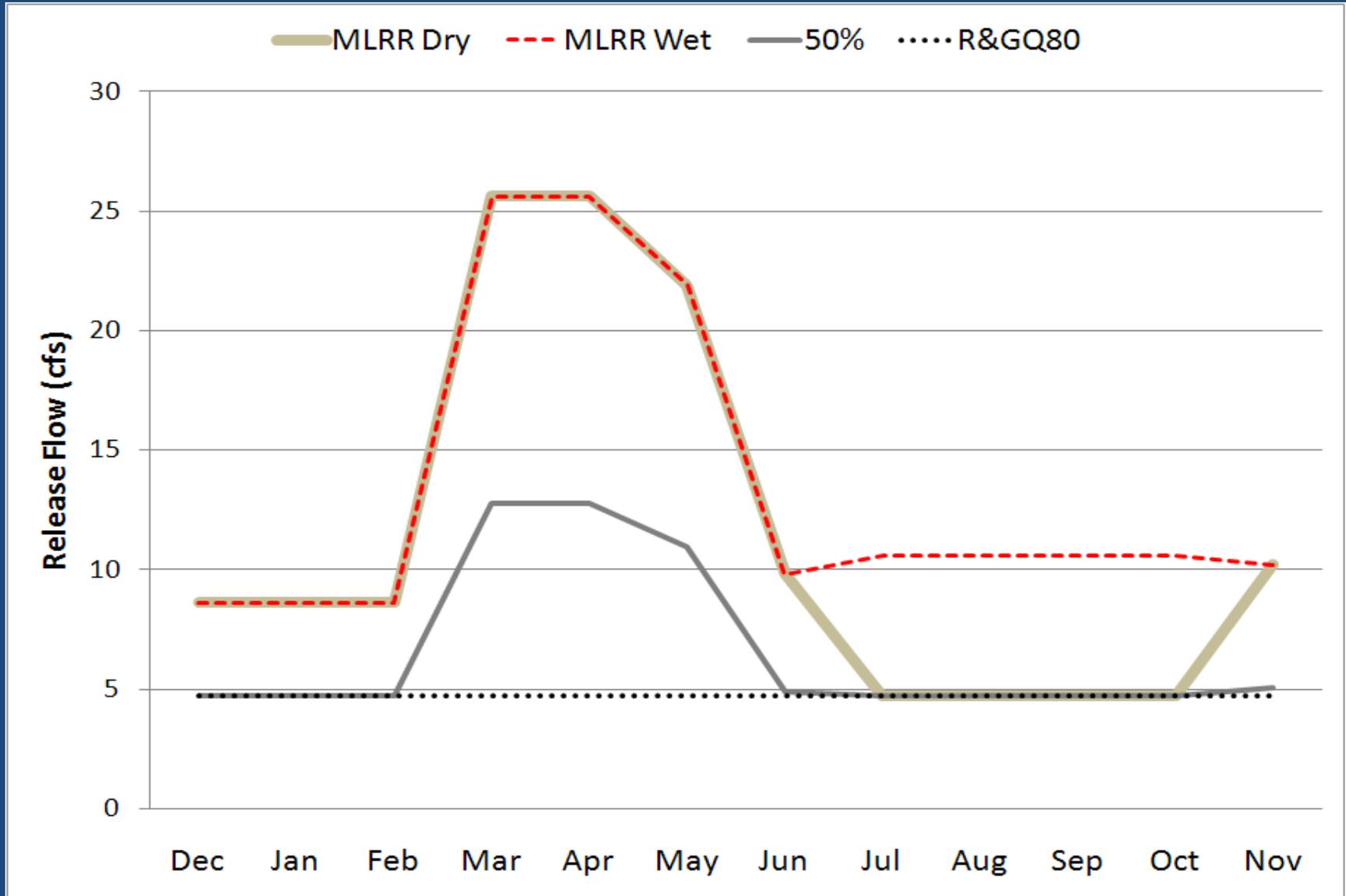
DEEP Approval

Reduce Release* up to 50% to Preserve MOS
(For > 10 years)

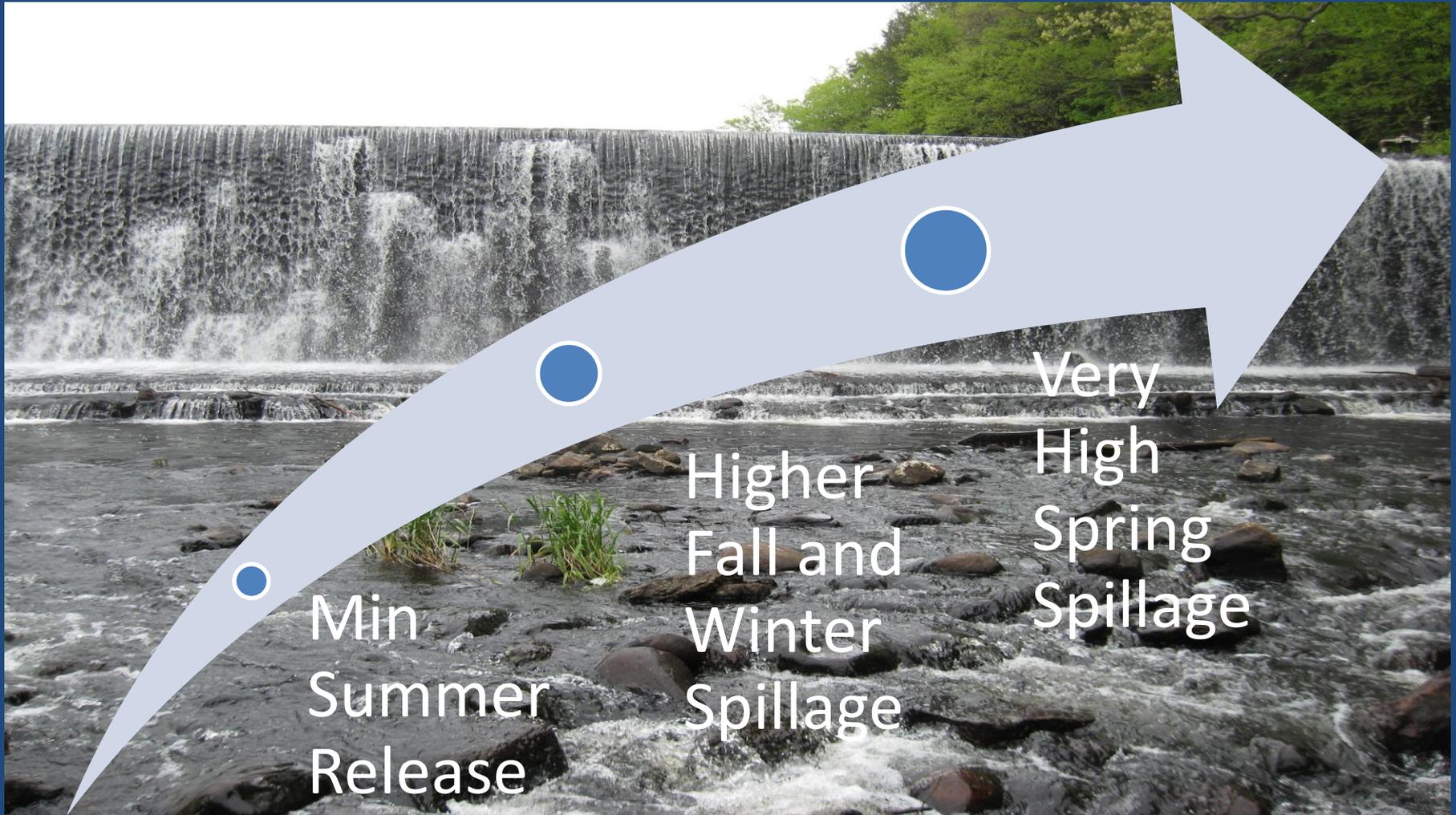
Reduce Release > 50% to Preserve MOS

* Not less than RG Q80

- 50% reduced releases to maintain adequate MOS



SMALL RESERVOIR FLOW VARIABILITY



Min
Summer
Release



Higher
Fall and
Winter
Spillage



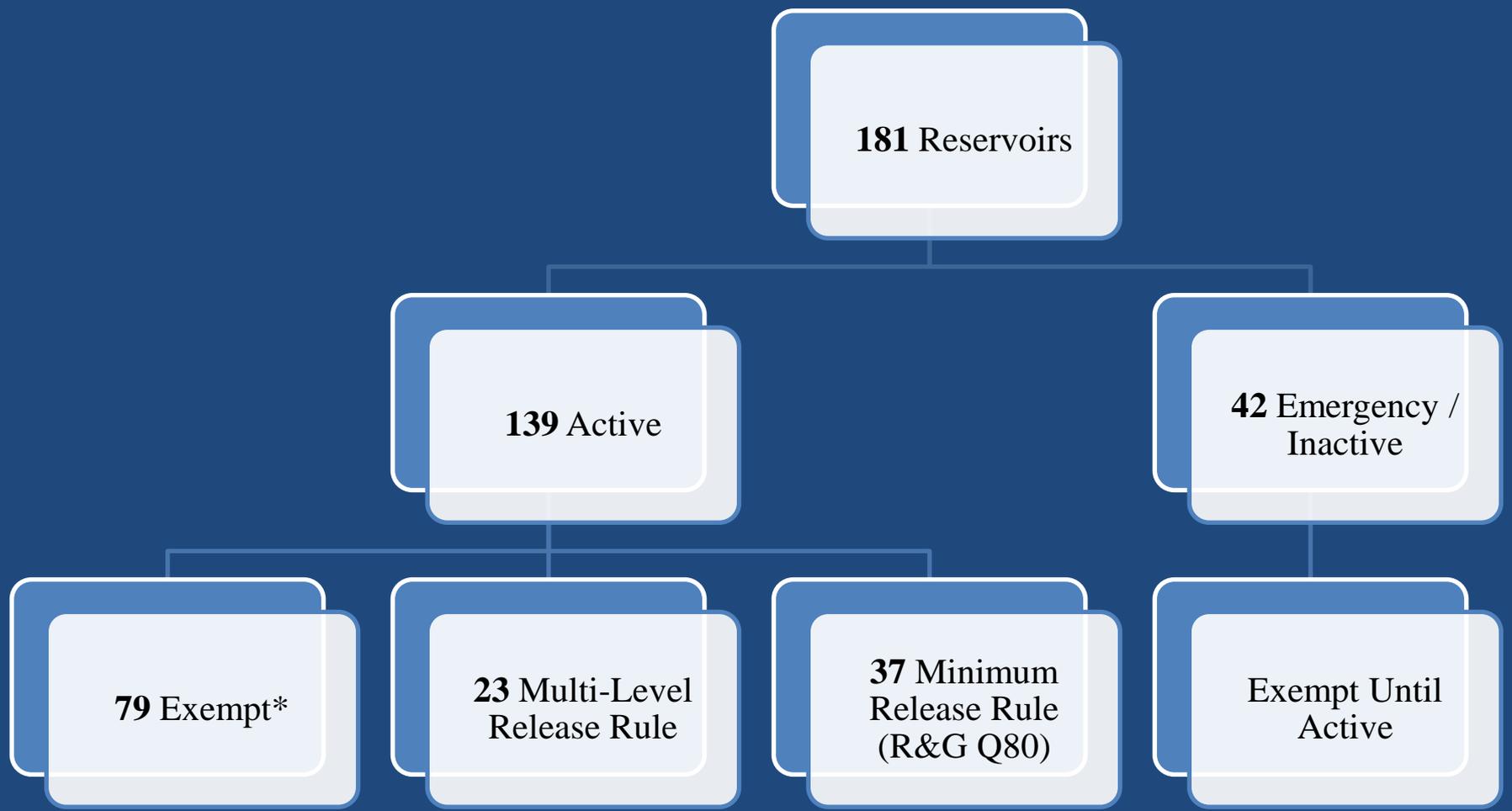
Very
High
Spring
Spillage

Reservoirs Subject to Minimum (RG Q 80) Release Rule Only
(< 3 SM watershed, short distance between impoundments, or
 < 100 MG usable storage)

Compliance Flexibility



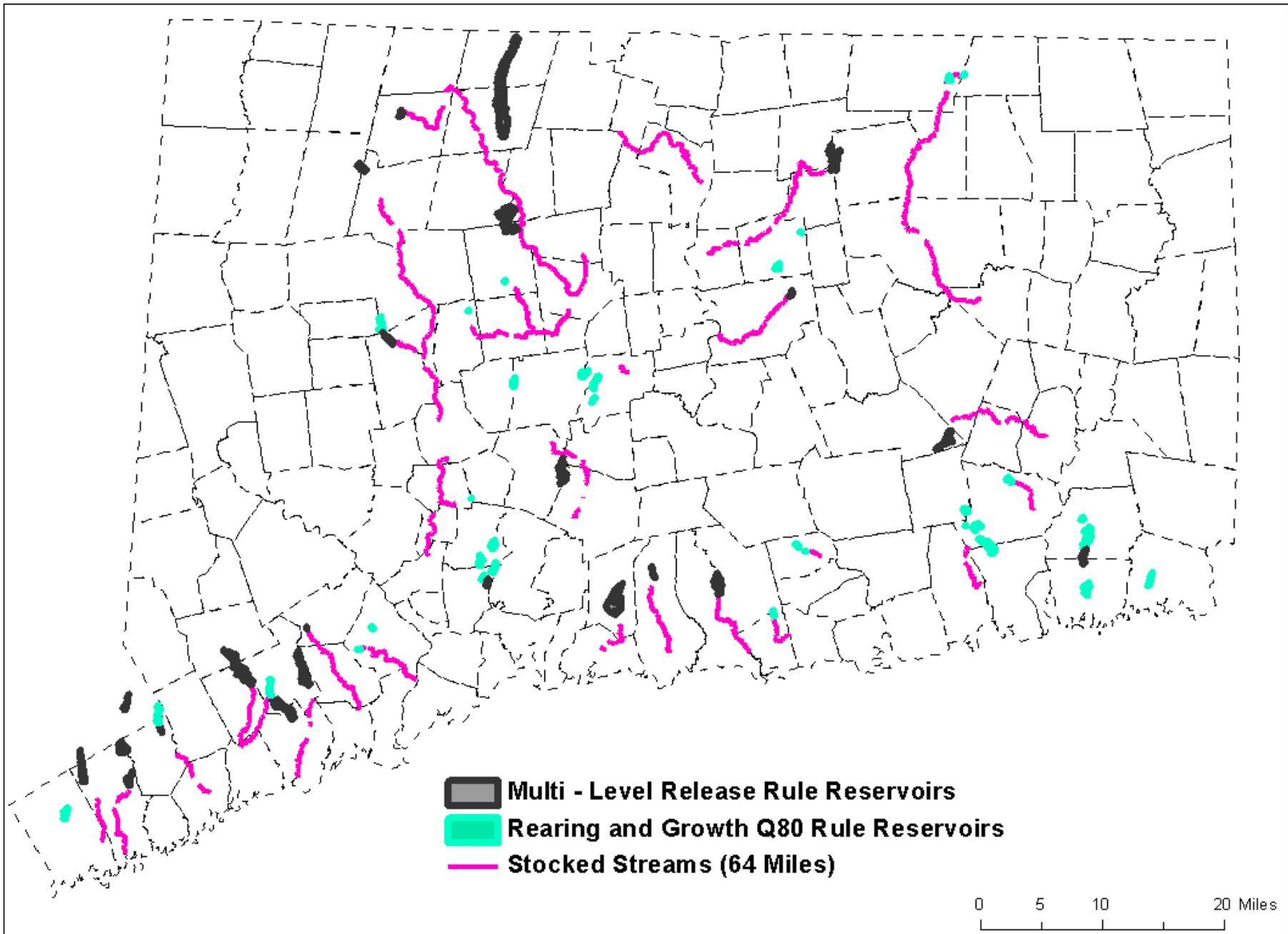
To the Best of Our Knowledge, the Stream flow Universe of Reservoirs

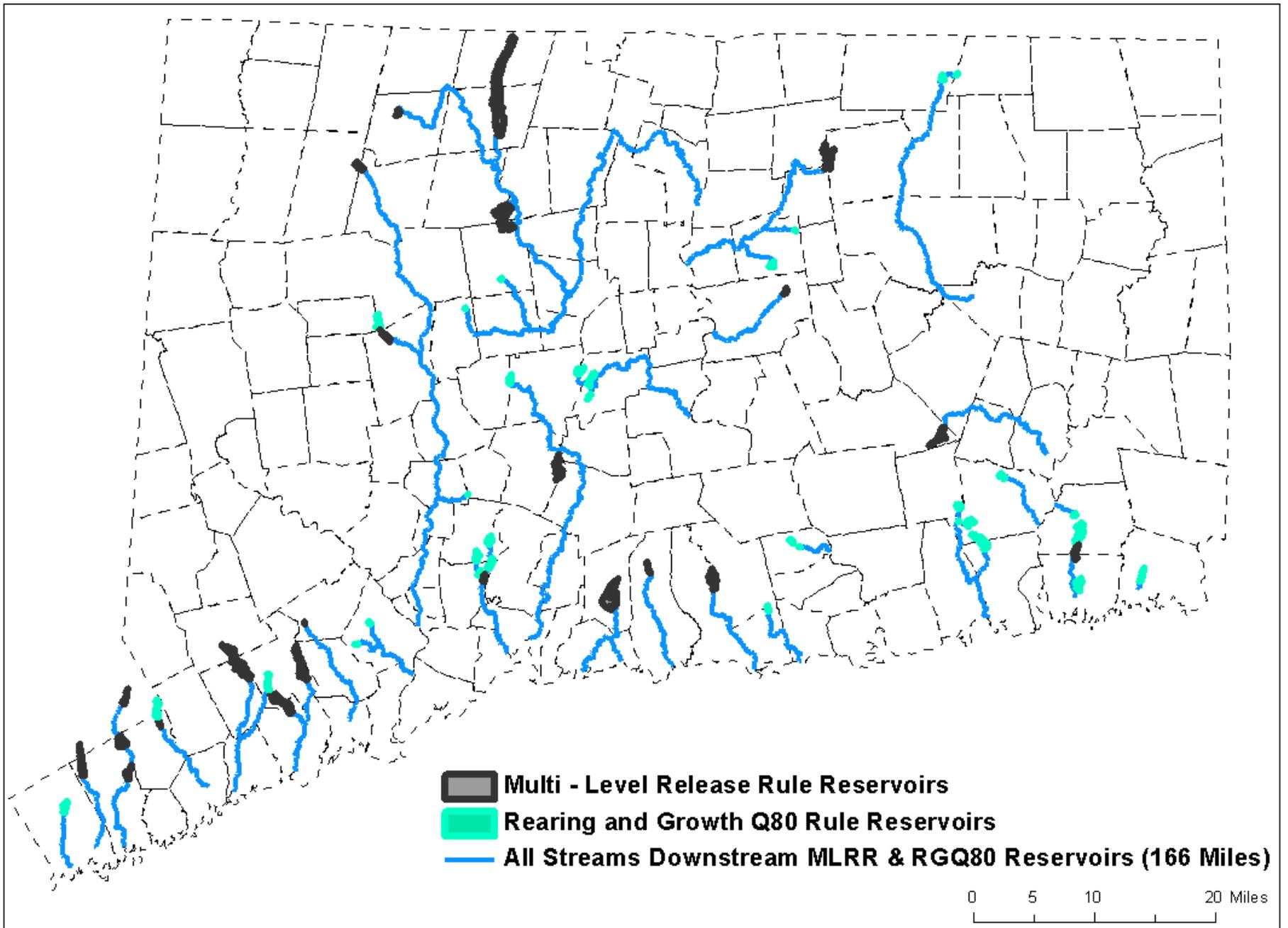


* Releases May Be Required for Permitted Reservoirs

Site Specific Release

- Option for Class 3
 - Needs to meet Class 3 Narrative Standard
 - Requires public notice
 - Commissioner Approval
- Required for Class 4
 - Best that can be accomplished toward Class 3 Narrative Standard





Reporting Requirements for Owners— Clock Starts at Classification

- At one year – provide basic information
- At nine years – methods and locations for calculating releases and demonstrating compliance
- At ten years and forward – maintain operating logs and report when requested

The Balance of a Public Trust Resource



A Step Towards Sustainable Stream Flow

26. 5. 2006

- **Balances Both Environmental & Human Needs**
- **Statewide Flow Classification System**
- **Provides Public Processes**
- **Considers Existing & Future Water Needs**
- **Provides Predictable “Blueprint” For Future Water Availability**

