

MassDEP
Water Management Program

Science Supporting Policy:
The Case For Flow Quantity

Integrating Water Resources Management
UMASS Conference
April 8, 2008

Overview

- Human impact on streamflow and aquatic habitat
- USGS Ipswich River studies
- USGS Index Flow studies
- WRC/DCR Index Flow Summary Statistics
- Stress Basin Re-designation
 - WRC/USGS Flow Alteration Indicators
- Sustainable Yield Estimator SYE
 - MassDEP/USGS Project (in progress)

WRC : Massachusetts Water Resources Commission

DCR: Massachusetts Department of Conservation and Recreation

Safe Yield

- 1980s Safe Yield (SY) methodology developed
- 1990s Safe yield methodology found inadequate
- 2000 ... USGS performs 5 Ipswich studies
- 2003 DEP issues modified Ipswich permits with protective streamflow conditions based on USGS findings
- 2004 ... DEP Policy revisions for statewide application of USGS emerging science on streamflow and habitat

Safe yield for
water supply

Safe yield for the
environment

A. Downstream view, 8-26-98



B. Downstream view, 6-17-99



Upstream of Route 28
in North Reading

USGS WRIR 01-4161



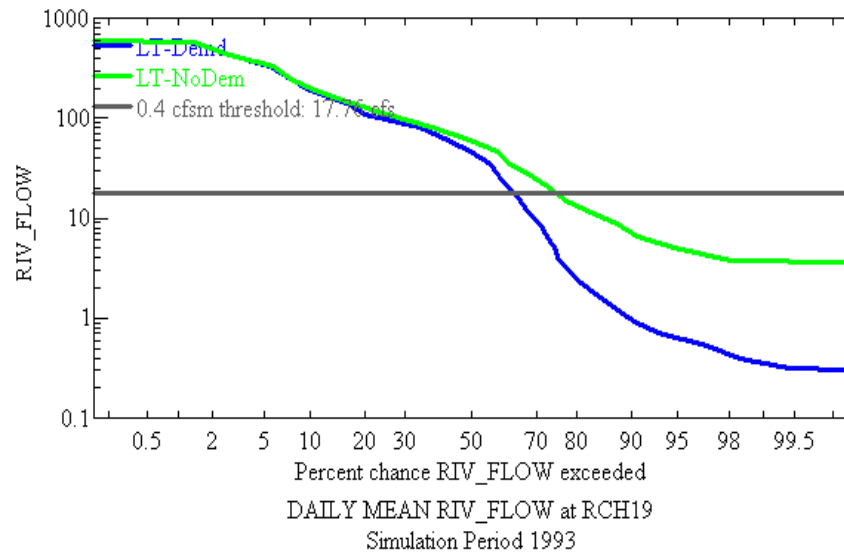
Fish kills and mussel die-off in the Ipswich River, 1995 and 1999.

USGS WRIR 01-4161



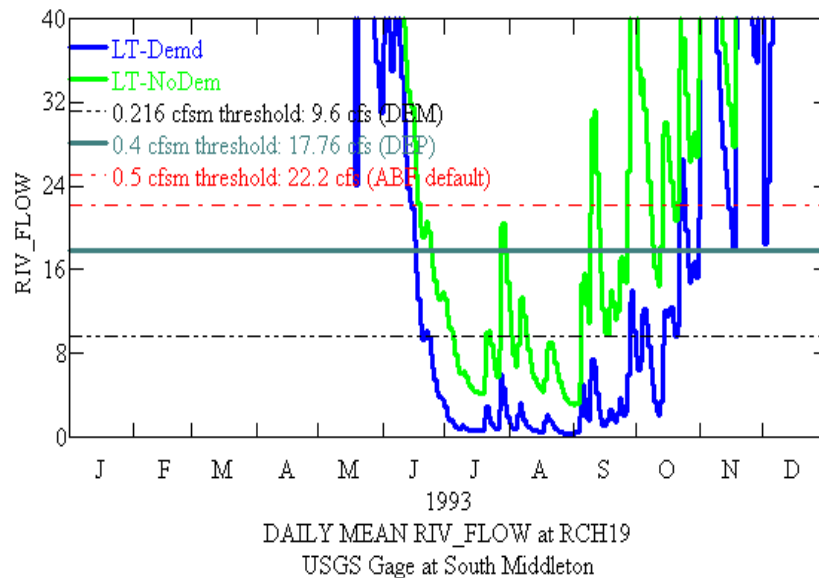
Ipswich River Studies

- A Precipitation-Runoff Model for Analysis of the Effects of Water Withdrawals on Streamflow, Ipswich River Basin, Massachusetts
WRIR 00-4029 HSPF Ipswich Model
- Assessment of Habitat, Fish Communities, and Stream Flow Requirements For Habitat Protection, Ipswich River, MA, 1998-1999
WRIR 01-4161
- Effects of Alternative Water Management Plans on Streamflow in the Ipswich River Basin, Massachusetts **OFR 01-483**
- Simulation of Reservoir Storage and Firm Yields of Three Surface-Water Supplies, Ipswich River Basin, Massachusetts **WRIR 02-4278**
- Simulated Effects of the 2003 Permitted Withdrawals and Water-Management Alternatives on Reservoir Storage and Firm-Yields of Three Surface-Water Supplies, Ipswich River Basin, Massachusetts
SIR 2004-5122



USGS South Middleton Gage Reach 19

Long-term simulations (1961-95) for a 1993 flow duration snapshot indicate an order of magnitude difference between scenarios of no withdrawals, about 3.0 cfs, and those with average withdrawals, about 0.3 cfs at the 99.8 percent exceedence probability.



Long-term simulations with 1993 hydrograph indicate low flow levels under average withdrawals during July, August and September.

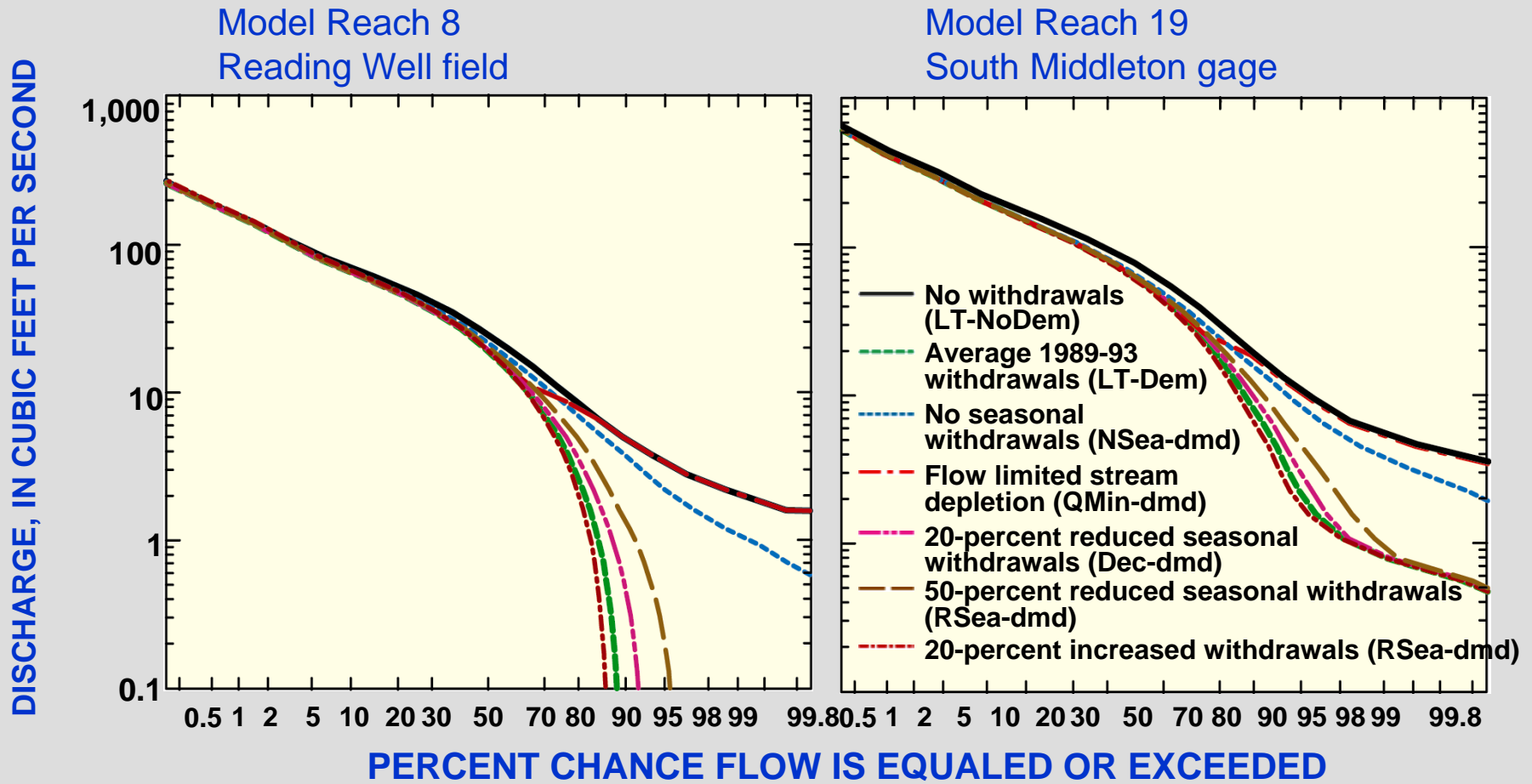
Stream cfsm thresholds of 0.2, 0.4 and 0.5 are compared to scenarios of no withdrawals and average withdrawals for the USGS gage at Reach 19.

In August 1999, water withdrawals upstream of gage pumped 7.53 mgd, or 11.7 cfs; while the average daily measured flow in the stream was 0.17 cfs

Water Management Alternative Scenarios

Water Supply Flow Duration

USGS OFR 01-483



Decreases in seasonal withdrawals from 20 to 50% do not appreciably change the streamflow depletion rate.

No seasonal withdrawals and 50% seasonal reduction based on 6-month period (May – Oct)
20% decrease withdrawals based on 4-month period (June through September)

Low Flow Streamflow Requirements for 4 Riffle Sites

Reach	Method				Approach			
	Tenn.	ABF	WP	R2Cross	Mean of 4	Median of 4	Mean of 3	Median of 3
8	0.54	0.47	0.38	0.38	0.44	0.43	0.46	0.47
25	0.51	0.37	0.42	0.44	0.44	0.43	0.43	0.42
41	0.49	0.27	0.56	0.42	0.44	0.43	0.39	0.42
59	0.48	0.27	0.46	1.39	0.65	0.47	0.40	0.46
				average	0.49	0.45	0.42	0.44

0.49

The minimum streamflow value by averaging the values determined by the 4 methods at each of the 4 study sites. Similar to the ABF summer default of 0.5 cfs.

0.42

Adjusting for 3 of the 4 riffle sites having altered channels, a reasonable minimum streamflow for habitat protection obtained from these 4 methods is 0.42 cfs.

This mean flow represents an average flow exceedence value for 6 sites of about 77% under simulated flow with no withdrawal.

Based on USGS Ipswich Habitat Assessment presentation to WRC and WRIR 01-4161

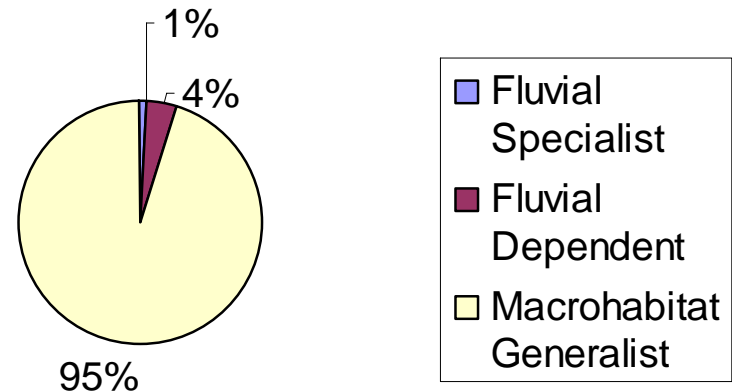
FISH SPECIES HABITAT CLASSIFICATION

- FLUVIAL-SPECIALIST
flow dependent throughout life
ex. brook trout
- FLUVIAL-DEPENDENT
flow dependent for specific life stage
ex. white suckers
- MACRO-HABITAT GENERALISTS
tolerant of low-flow, warm water and
ponded conditions
ex. redfin pickerel, American eel

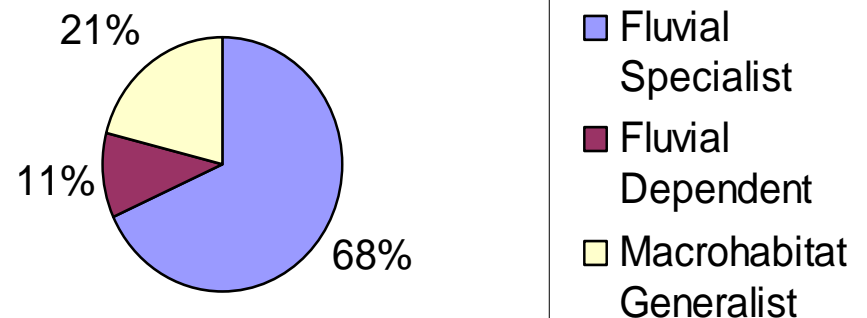
The Lamprey River, with a drainage basin of 183 sq. miles, is a coastal river in New Hampshire about 30 miles north of the Ipswich River.

USGS WRIR 01-4161

Ipswich River Fish Sample Distribution



Lamprey River, N.H. Fish Sample Distribution



Water Management Ipswich Goal

A Better Balance:

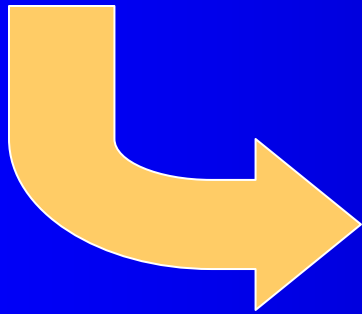
Water withdrawal uses balanced with protection of aquatic habitat/natural environment and economic interests.

Objectives

- Establish environmental trigger with streamflow thresholds for habitat protection
- Establish framework for required mitigation measures tied to stream thresholds
 - Restriction on nonessential outside water use
- Performance standards:
 - 65 Residential gallons per capita day
 - 10% or less for Unaccounted-for-water
- Ensure adequate water supply for the protection of public health and safety

More Science-based Policy

- Hold water volumes
- Performance standards
- Required conservation
- Streamflow triggered restrictions



- All Ipswich permits appealed
- DEP WMA Permitting Policy
- Blue Ribbon Panel
- 10-year Registration Renewal
- 20-year Permit Renewal

USGS Index Flow

- Streamflow characteristics and methods for determining streamflow requirements for habitat protection
- Monthly flow durations and low flow statistics
- Streamflow hydrology: magnitude, frequency, duration, timing and rate of change
- Established hydrologic reference flow based on least-altered stream gages

- Evaluation of Streamflow Requirements for Habitat Protection by Comparison to Streamflow Characteristics at Index Streamflow-Gaging Stations in Southern New England **USGS WRIR 03-4332**

- Use of Hydrologic Indices to Characterize and Classify Streamflows in Massachusetts **USGS SIR 200X-XXX** (in progress)

Index Streamflows For Massachusetts /Draft

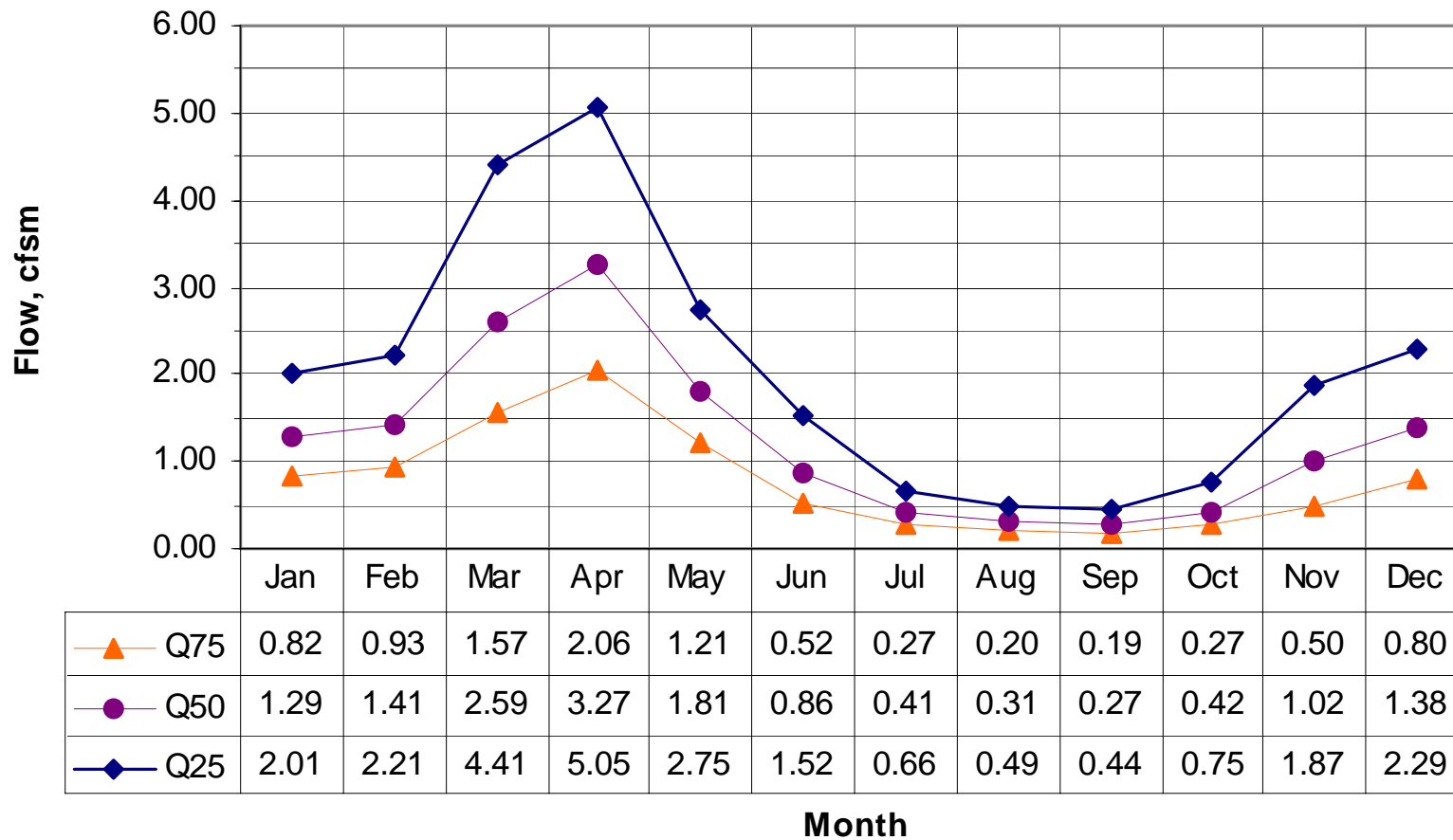
Water
Resources
Commission

- 2007 Index Streamflows Draft: streamflow requirements and streamflow characteristics for southern New England
- Target hydrographs with monthly quartiles of flow and Aquatic Base Flow
- Indicators of Hydrologic Indices (IHA) with parametric and non-parametric analyses
- Massachusetts Index Gage characteristics
- Annual Target Hydrograph Analysis comparing an index gage with a non-index gage

www.mass.gov/envir/mwrc/streamflows.htm

Massachusetts Streamflow Target Approach

Summary of Values 01096000 Squannacook River MA 1960 to 2004



Surrogates for an Integrated Streamflow Environment

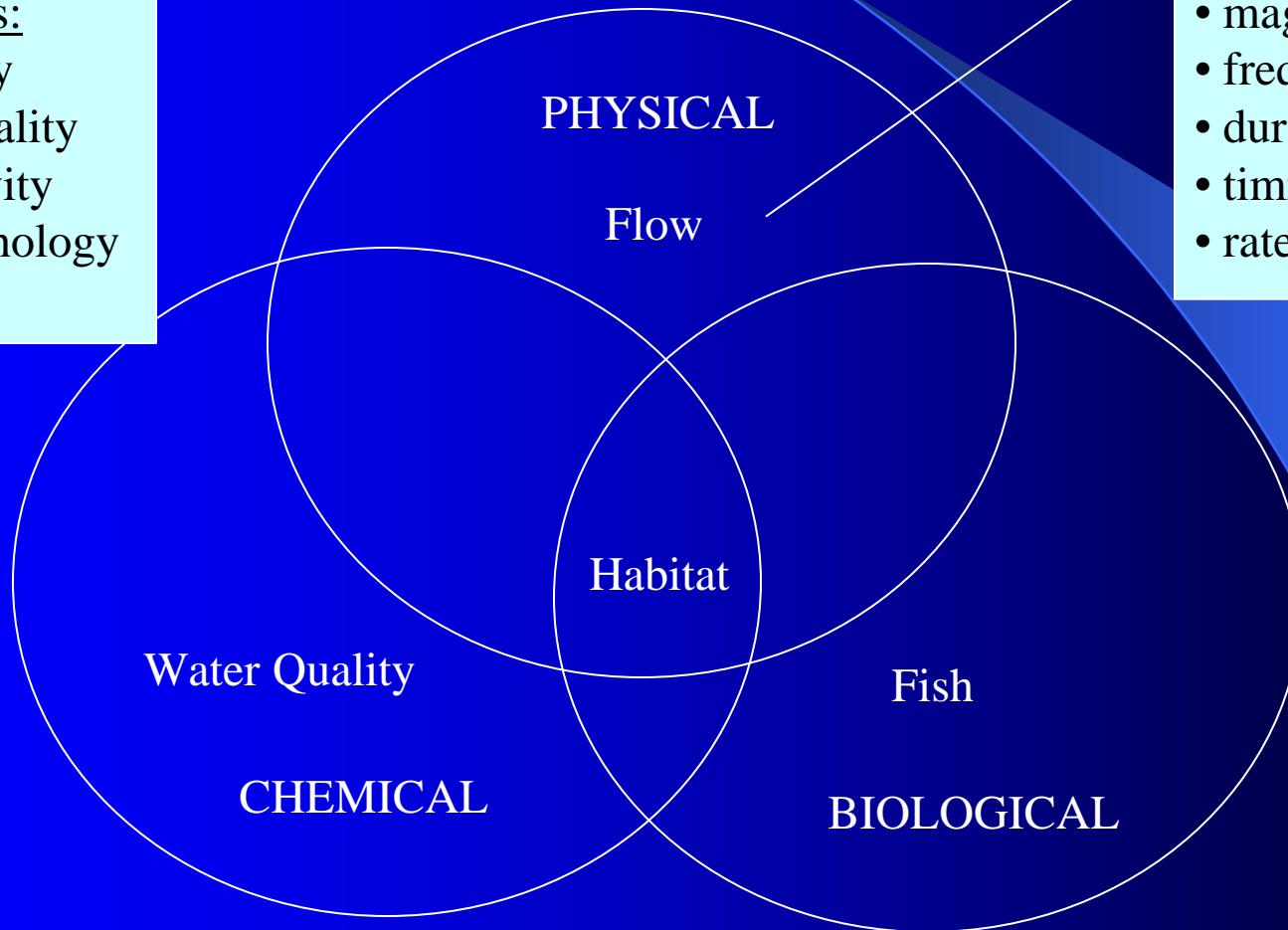
Riverine

components:

- Hydrology
- Water Quality
- Connectivity
- Geomorphology
- Biology

Streamflow:

- magnitude
- frequency
- duration
- timing
- rate of change



Stress Redefined

- Flow Alteration Indicators:
 - Impacted/Unimpacted Ratio (I/U) for select flow metrics
 - Relative Net Water Demand
 - Impoundment indicators
 - Dam Density and Fragmentation Index
- Water Quality Alteration Indicators
 - 303d List of impaired waters: select indicators
- Biological Alteration Indicators:
 - Target fish community
 - Fish community percent similarity

A work in progress

Sustainable Yield Estimator (SYE)

- Screening level tool that evaluates the effects of withdrawals on streamflows
- At any ungaged location on a perennial stream
- Delineates contributing drainage area
- Estimates natural flow
- Estimates impacted flow
- Compare to user-defined target flow

New methods for
estimating flow
duration curves at
ungaged sites

MassDEP/USGS Sustainable Yield Estimator (in progress)

Policy Developing with Emerging Science

- Fixed management → Adaptive management
- Individual withdrawal effect → Cumulative effects
- Safe Yield number → SY in time and space; no single number
- Off-stream water supply use → Off-stream and in-stream uses
- Minimum streamflow → Natural variability / annual hydrograph
- Impacted gage flow → Index gage flow
- Flow stress → Physical, chemical, biological stress
- Safe yield for water supply → Sustainability for water supply and the environment

—————→ **BETTER BALANCE**

MassDEP

Water Management Act Program

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