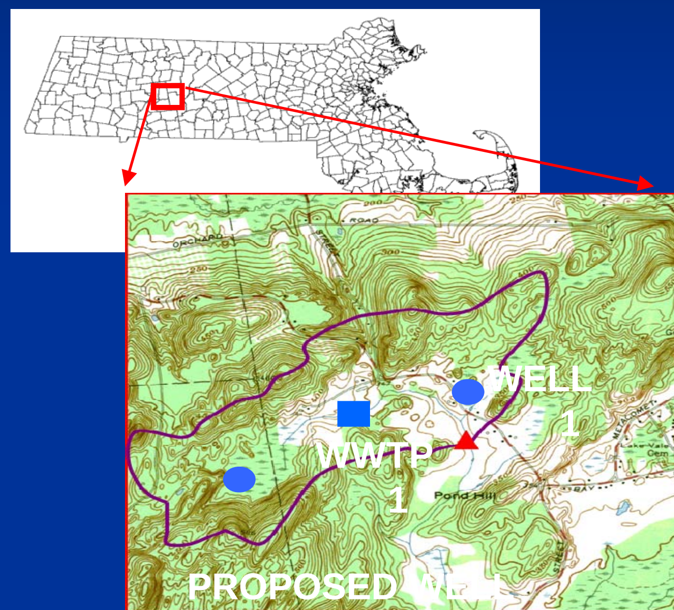
# Sustainable Yield Estimator in Massachusetts Water Management




Linda Marler Hutchins, Hydrologist
MA Department of Conservation and Recreation

MN Ground Water Association
May 4, 2011

# Summary

- Massachusetts Hydrogeology
- Massachusetts Water Management Act (WMA)
- “Safe Yield” and “Streamflow Criteria”
- Sustainable Yield Estimator (SYE)
- Massachusetts Sustainable Water Management Initiative (SWMI)

# Minnesota and Massachusetts



**Minnesota:**

***Land of 10,000 Lakes***
***(The Gopher State)***

**Area: 86,939 Sq Mi**

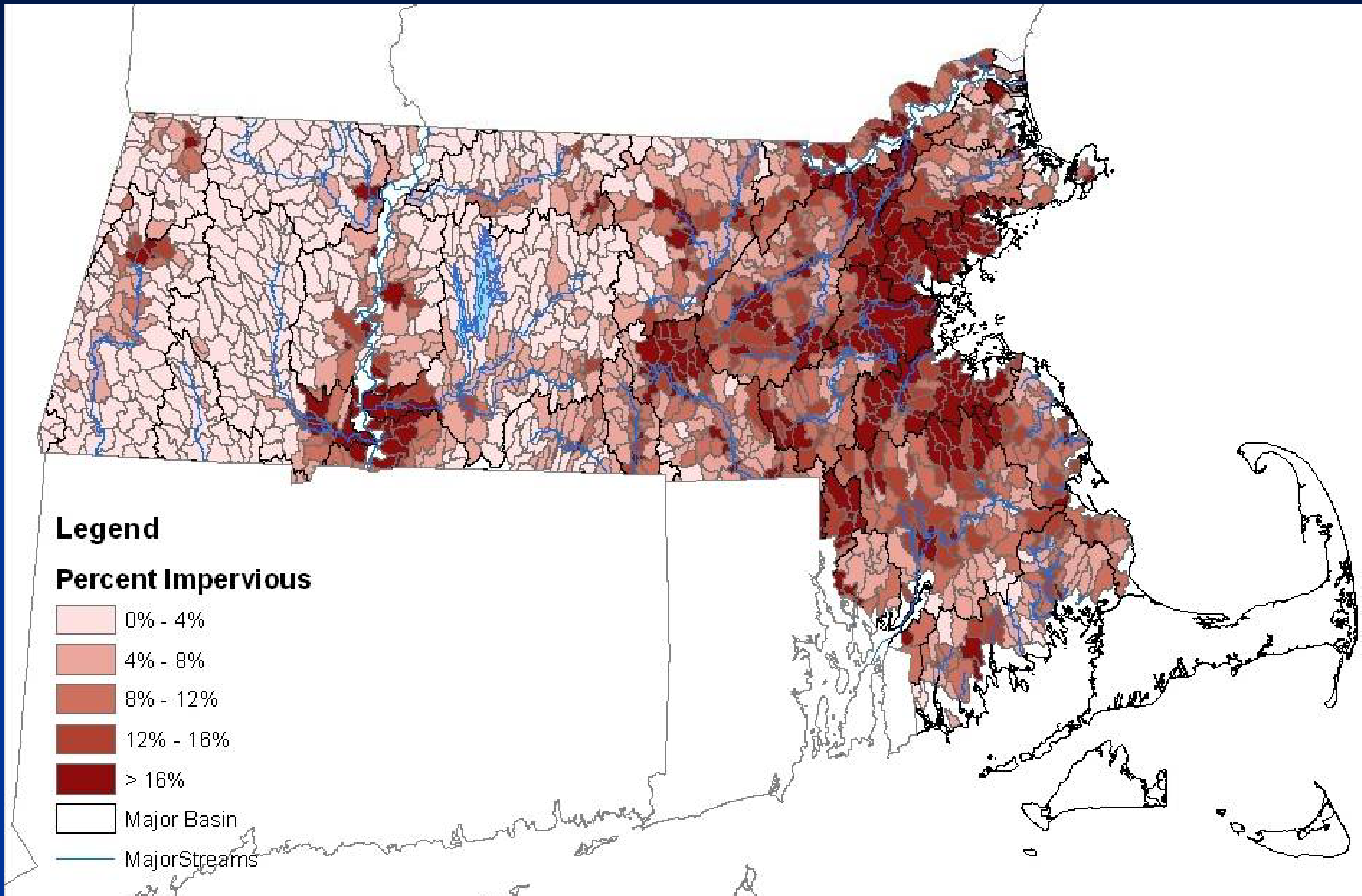
**Population: 5.3 Million**

**Massachusetts:**

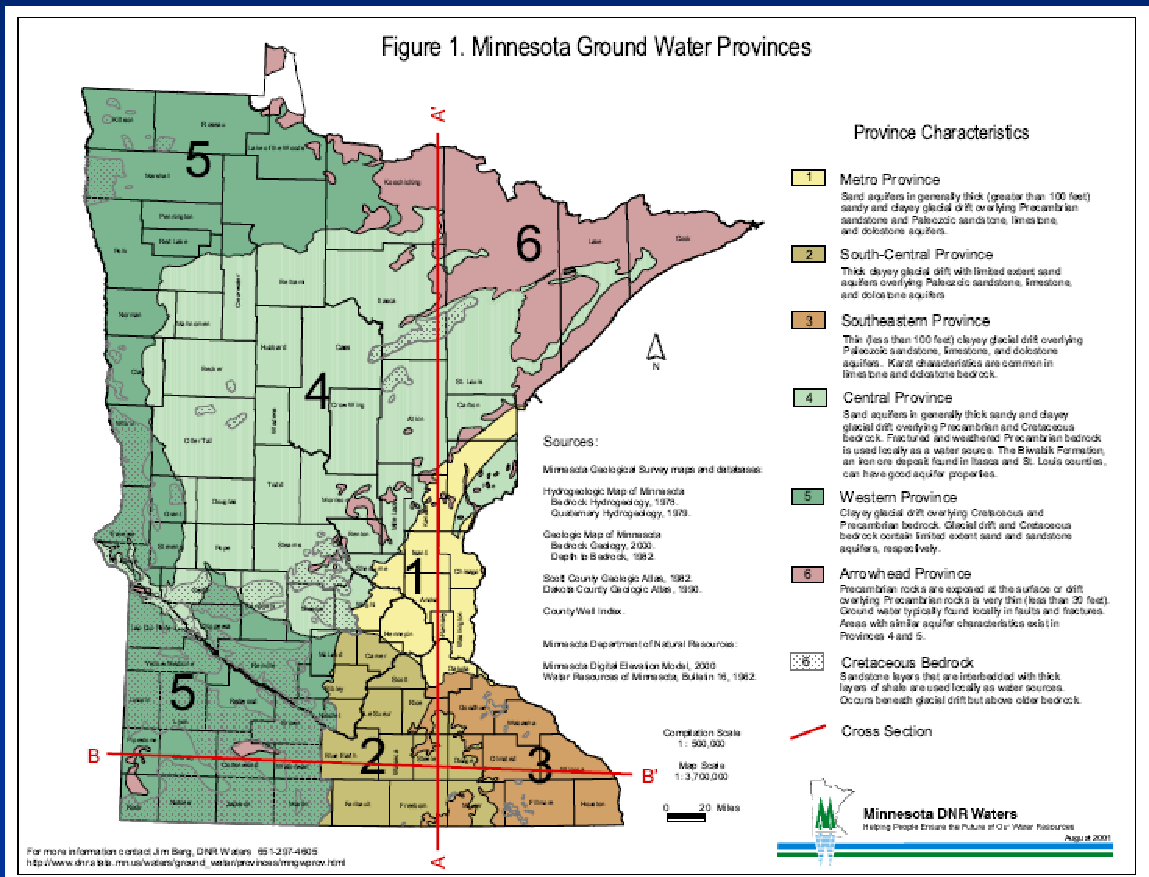
***The Bay State***
***(Taxachusetts)***

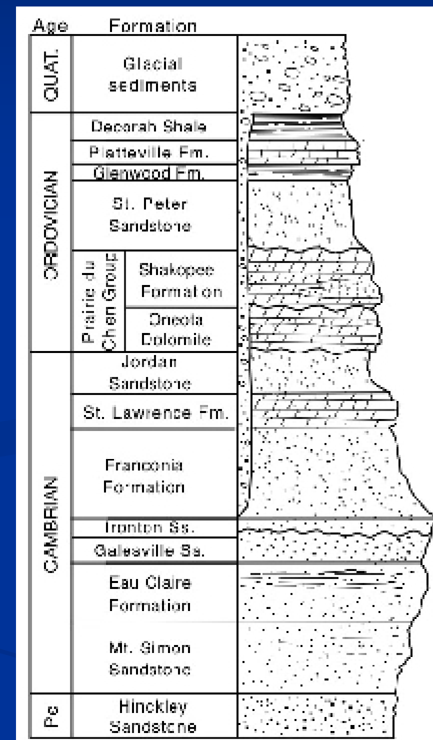
**Area: 10,555 Sq Mi**

**Population: 6.5 Million**

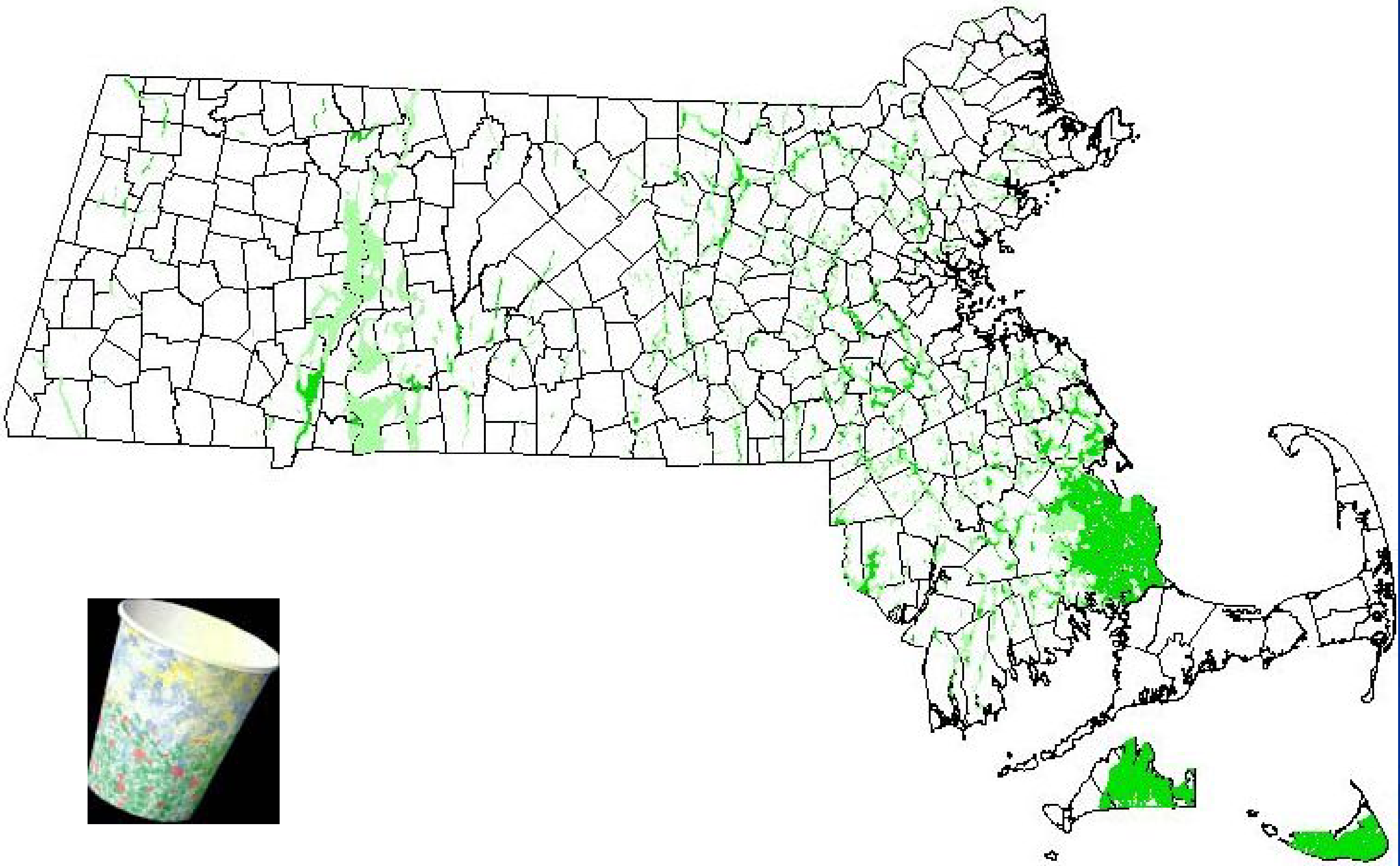

Legend
Percent Impervious
0% - 4%
4% - 8%
8% - 12%
12% - 16%
> 16%
Major Basin
MajorStreams

# Minnesota Geology

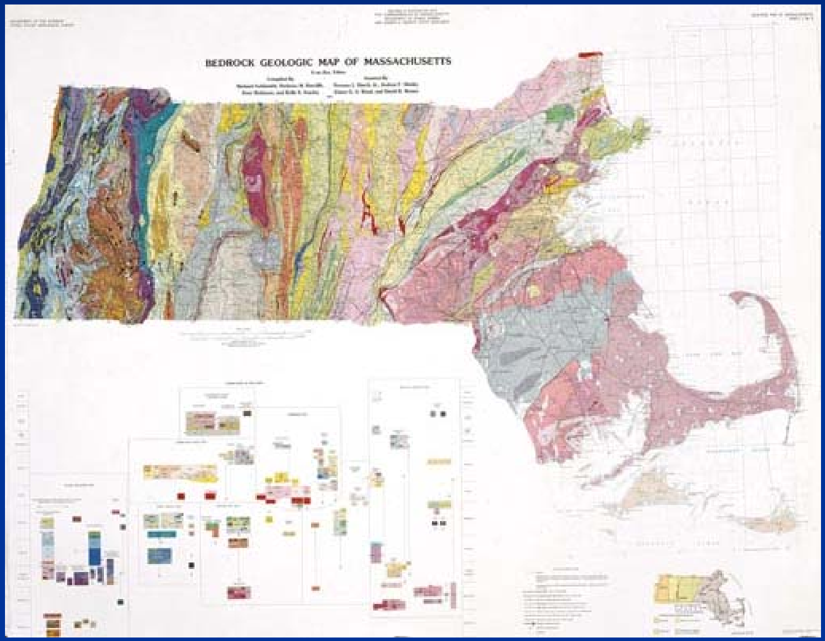


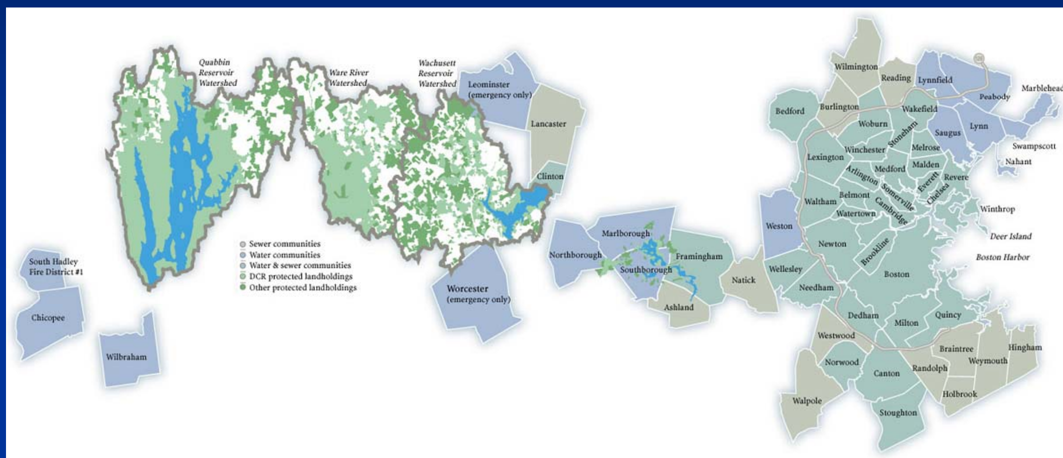
# Massachusetts Aquifers



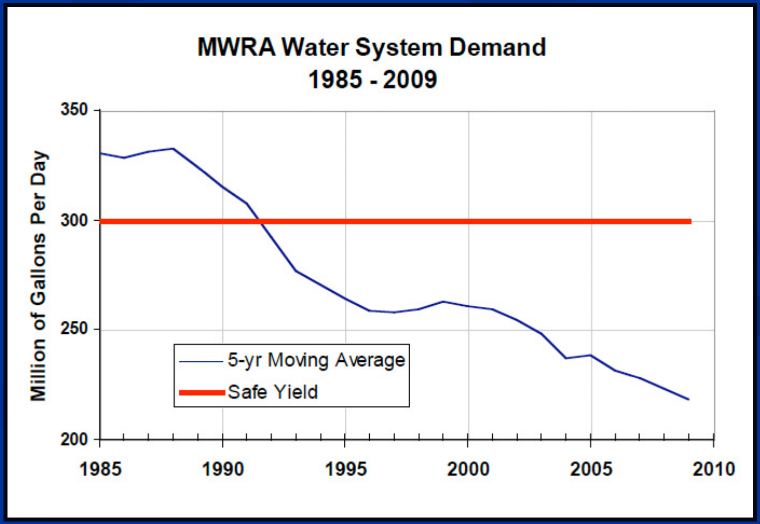
# Massachusetts Bedrock



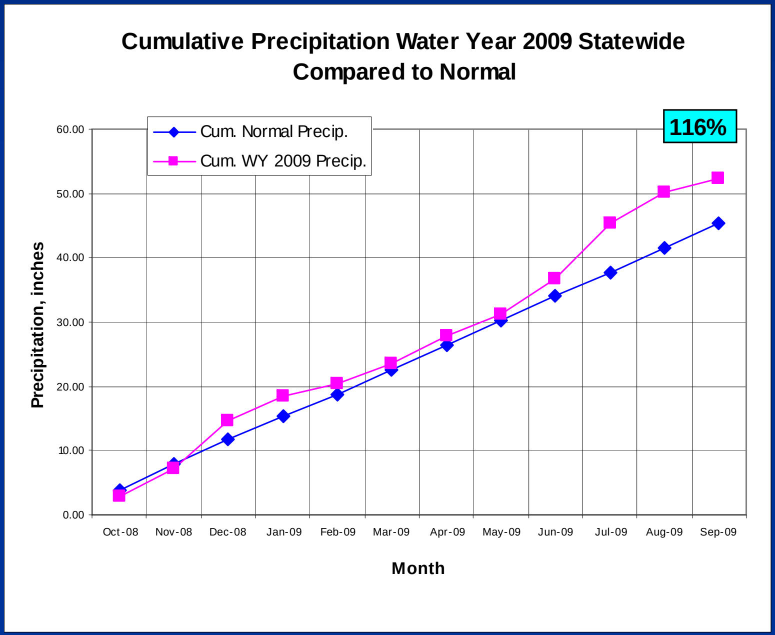

# MWRA Regional Water Supply to Boston Metro Area

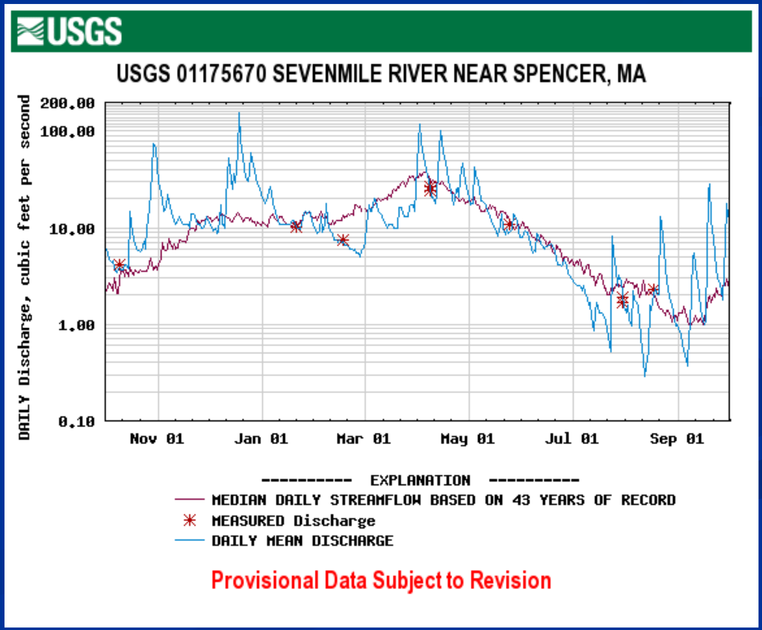



2.2 million people served
215 MGD Average

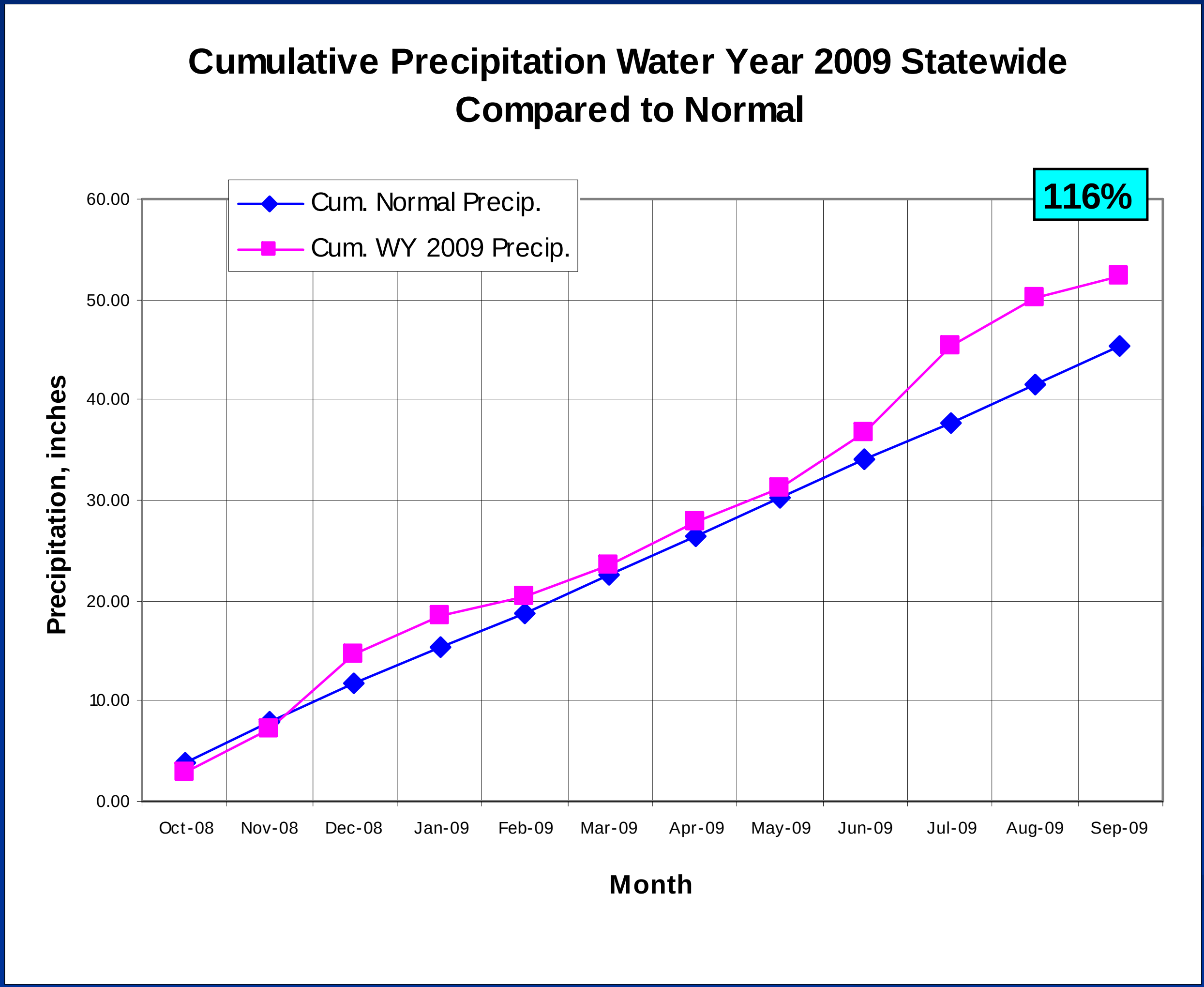



# Typical New England Flow Pattern
# Water Year October-September



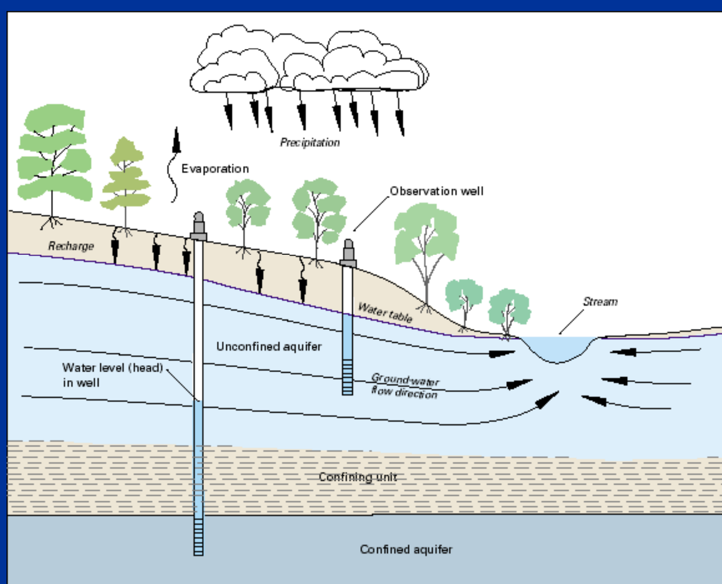



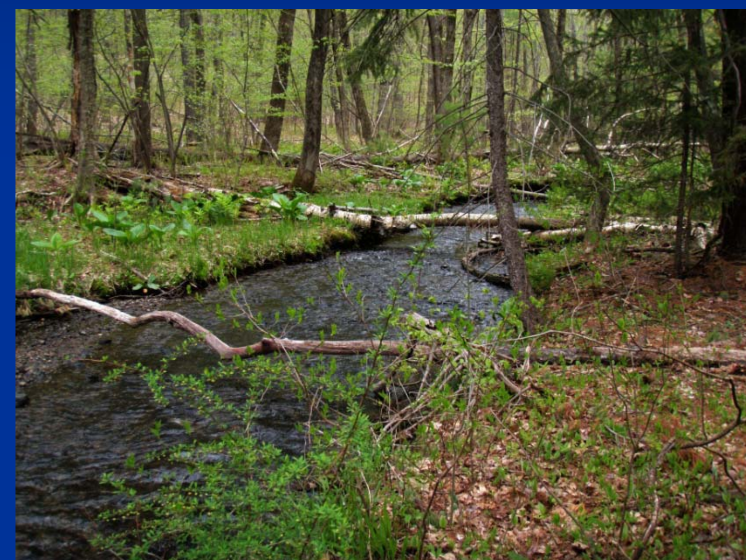
# Massachusetts Annual Rainfall Pattern



# MA Seasonal Streamflow Pattern

- **Summer Low-Flow Season**
  - High Evapotranspiration
  - ET> Precipitation
  - Streams rely on ground water recharge for “base flow”



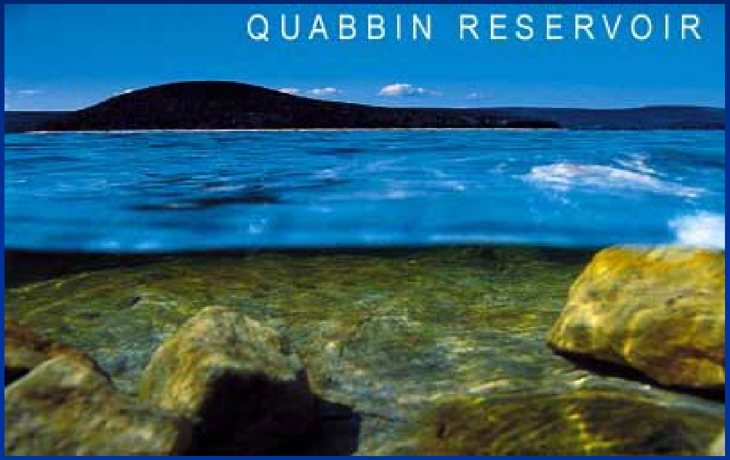



*Water demand is highest when streamflow is the lowest….*

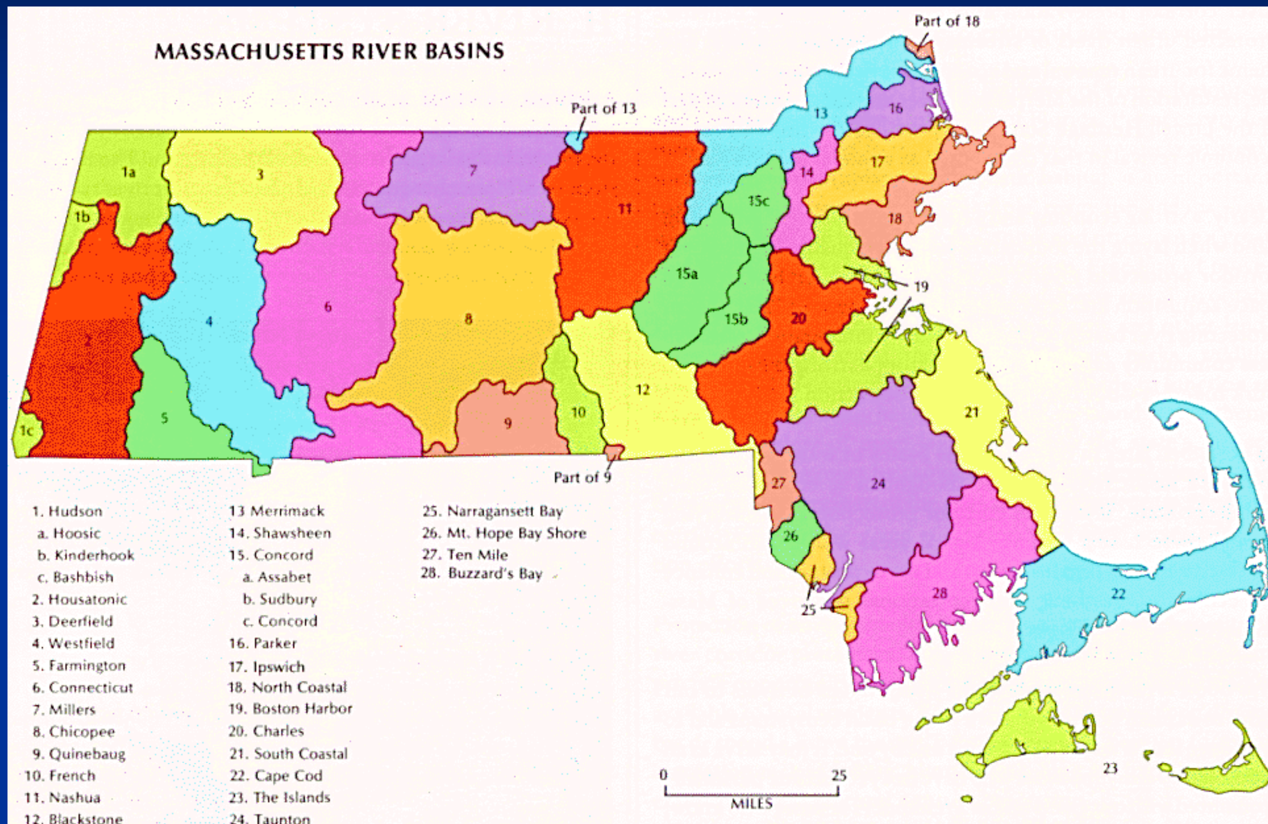
# 1987 MA Water Management Act

## Department of Environmental Protection

- Existing water withdrawals >100,000 gallons per day **Registered** their 1981 to 1985 use
- New or increased withdrawals subject to **Permits**
- Permits are subject to:
  - Major Basin Safe Yield Limits
  - Environmental Review
  - Water Conservation Standards
    - 65 rgpcd
    - 10% Unaccounted-for Water (UAW)




# Massachusetts Major River Basins




**Water Management Act manages water withdrawals in Major Basins**
**Limits total permitted withdrawal to a "Safe Yield" for each Major Basin**

# WMA "Safe Yield"

"the maximum dependable withdrawals that can be made continuously from a water source including ground or surface water during a period of years in which the probable driest period or period of greatest water deficiency is likely to occur; provided, however, that such dependability is relative and is a function of storage and drought probability."

***Environment??***

# 2009 DEP Issues Safe Yield Values for 27 Major Basins

# DEP Safe Yield Clarification

**November 3, 2009**

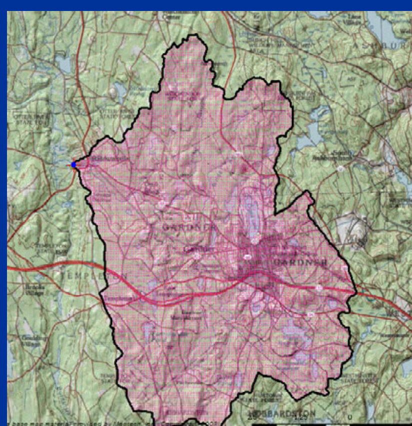
"MassDEP clarifies and explains that its interpretation of the term safe yield under the Water Management Act includes environmental protection factors, including ecological health of river systems, as well as hydrologic factors."

# Massachusetts Sustainable Water Management Initiative 2009-2010-2011….


- Technical Subcommittee
- Advisory Subcommittee
- Agency Technical Staff Meetings
- Steering Committee
- Implementation Tools Committee
- Facilitated Meetings
- Stakeholders

# Streamflow ~~Standards~~ Criteria

Envisioned to protect streamflow at smaller geographic and time scale than Safe Yield



*NO GRANDFATHERING!*

Will apply to all Water Management Act Permits

# MA Interagency Research

The Official Website of the Executive Office of Energy and Environmental Affairs

Energy and Environmental Affairs

MassWildlife

Massachusetts Division of Fisheries & Wildlife

*Wayne F. MacCallum, Director*

MassDEP

site map

Massachusetts Department of Environmental Protection

*Commonwealth of Massachusetts*

RIVERWAYS PROGRAM

*Building Partnerships, Protecting Rivers*

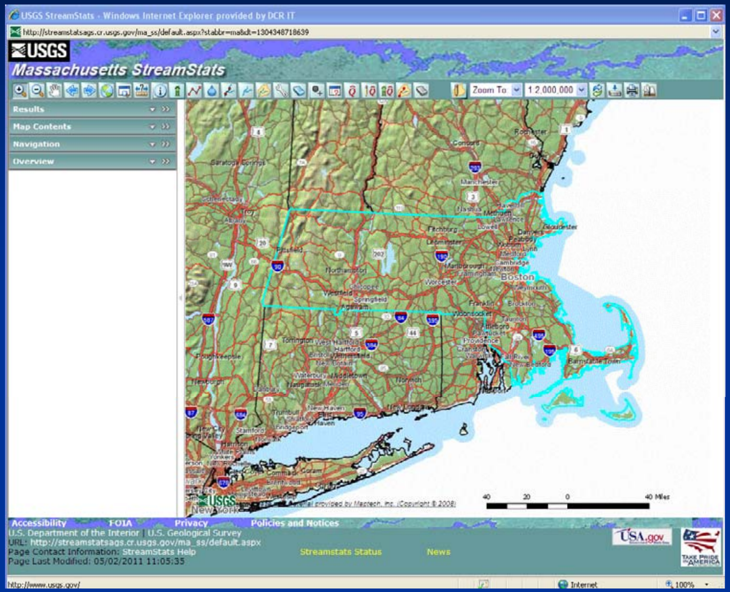
dcr

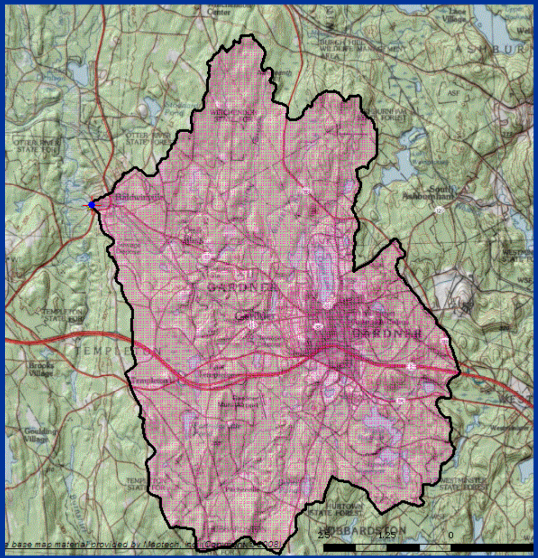
*department of* Conservation and Recreation

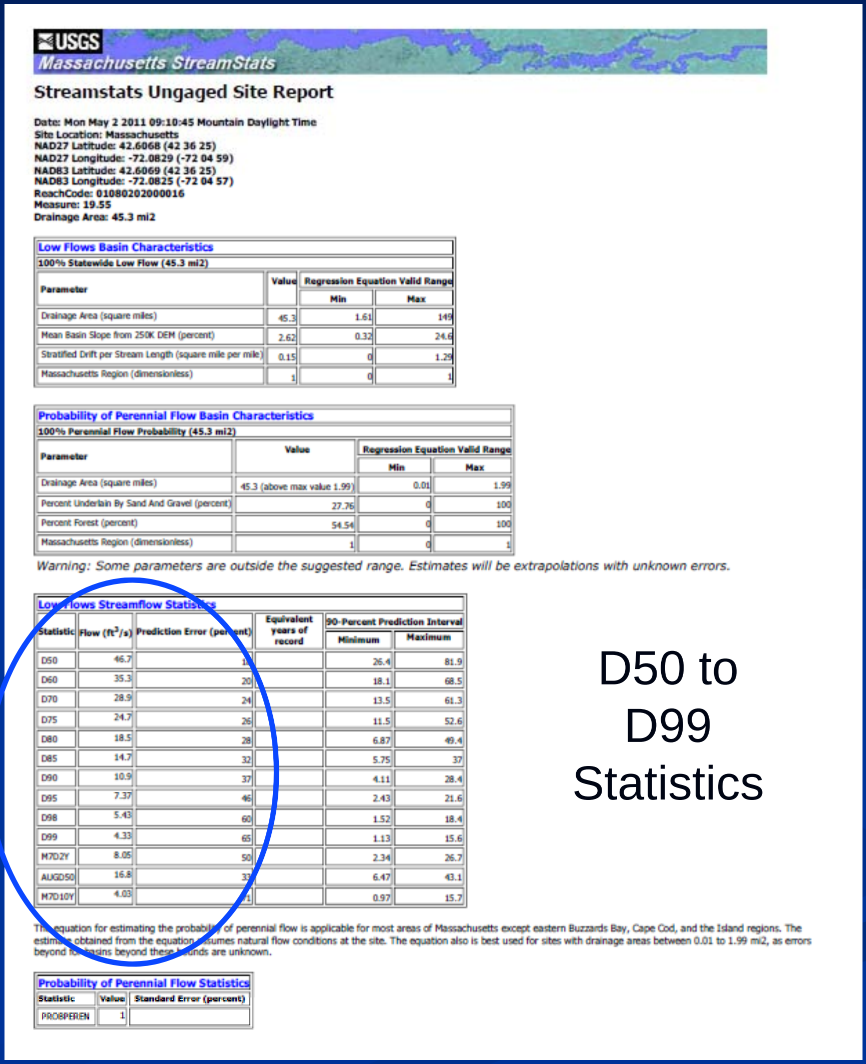
USGS

*science for a changing world*

# USGS StreamStats





USGS
Massachusetts StreamStats

## Streamstats Ungaged Site Report

Date: Mon May 2 2011 09:10:45 Mountain Daylight Time
Site Location: Massachusetts
NAD27 Latitude: 42.6068 (42 36 25)
NAD27 Longitude: -72.0829 (-72 04 59)
NAD83 Latitude: 42.6069 (42 36 25)
NAD83 Longitude: -72.0825 (-72 04 57)
ReachCode: 01080202000016
Measure: 19.55
Drainage Area: 45.3 mi2

**Low Flows Basin Characteristics**

100% Statewide Low Flow (45.3 mi2)

| Parameter | Value | Regression Equation Valid Range | |
|---|---|---|---|
| | | Min | Max |
| Drainage Area (square miles) | 45.3 | 1.61 | 149 |
| Mean Basin Slope from 250K DEM (percent) | 2.62 | 0.32 | 24.6 |
| Stratified Drift per Stream Length (square mile per mile) | 0.15 | 0 | 1.29 |
| Massachusetts Region (dimensionless) | 1 | 0 | 1 |

**Probability of Perennial Flow Basin Characteristics**

100% Perennial Flow Probability (45.3 mi2)

| Parameter | Value | Regression Equation Valid Range | |
|---|---|---|---|
| | | Min | Max |
| Drainage Area (square miles) | 45.3 (above max value 1.99) | 0.01 | 1.99 |
| Percent Underlain By Sand And Gravel (percent) | 27.76 | 0 | 100 |
| Percent Forest (percent) | 54.54 | 0 | 100 |
| Massachusetts Region (dimensionless) | 1 | 0 | 1 |

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

**Low Flows Streamflow Statistics**

| Statistic | Flow ($ft^3/s$) | Prediction Error (percent) | Equivalent years of record | 90-Percent Prediction Interval | |
|---|---|---|---|---|---|
| | | | | Minimum | Maximum |
| D50 | 46.7 | [illegible] | | 26.4 | 81.9 |
| D60 | 35.3 | 20 | | 18.1 | 68.5 |
| D70 | 28.9 | 24 | | 13.5 | 61.3 |
| D75 | 24.7 | 26 | | 11.5 | 52.6 |
| D80 | 18.5 | 28 | | 6.87 | 49.4 |
| D85 | 14.7 | 32 | | 5.75 | 37 |
| D90 | 10.9 | 37 | | 4.11 | 28.4 |
| D95 | 7.37 | 46 | | 2.43 | 21.6 |
| D98 | 5.43 | 60 | | 1.52 | 18.4 |
| D99 | 4.33 | 65 | | 1.13 | 15.6 |
| M7D2Y | 8.05 | 50 | | 2.34 | 26.7 |
| AUGD50 | 16.8 | 33 | | 6.47 | 43.1 |
| M7D10Y | 4.03 | [illegible] | | 0.97 | 15.7 |

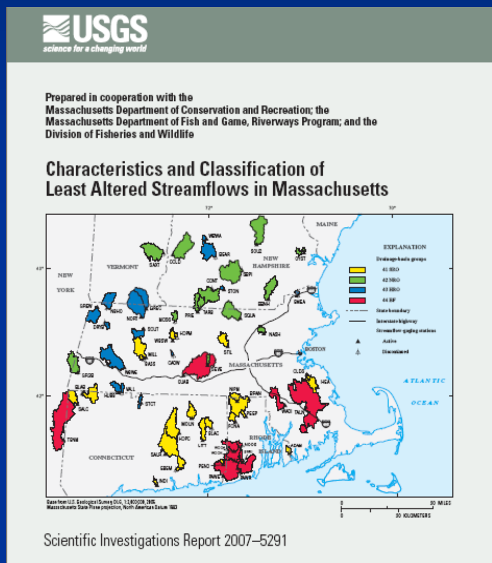
The equation for estimating the probability of perennial flow is applicable for most areas of Massachusetts except eastern Buzzards Bay, Cape Cod, and the Island regions. The estimate obtained from the equation assumes natural flow conditions at the site. The equation also is best used for sites with drainage areas between 0.01 to 1.99 mi2, as errors beyond for basins beyond these bounds are unknown.

**Probability of Perennial Flow Statistics**

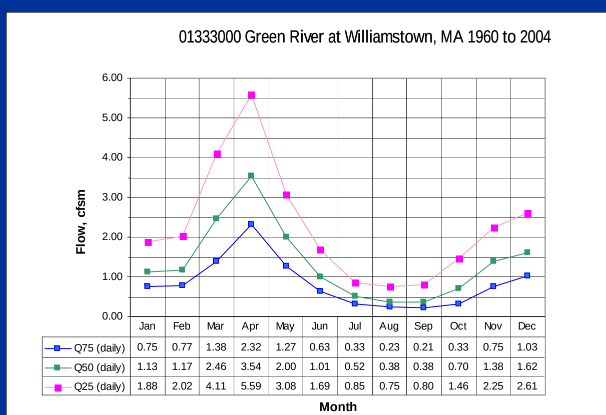
| Statistic | Value | Standard Error (percent) |
|---|---|---|
| PROBPEREN | 1 | |

D50 to D99 Statistics

# 2007 USGS Characteristics and Classification of Least-Altered Streamflows in Southern New England



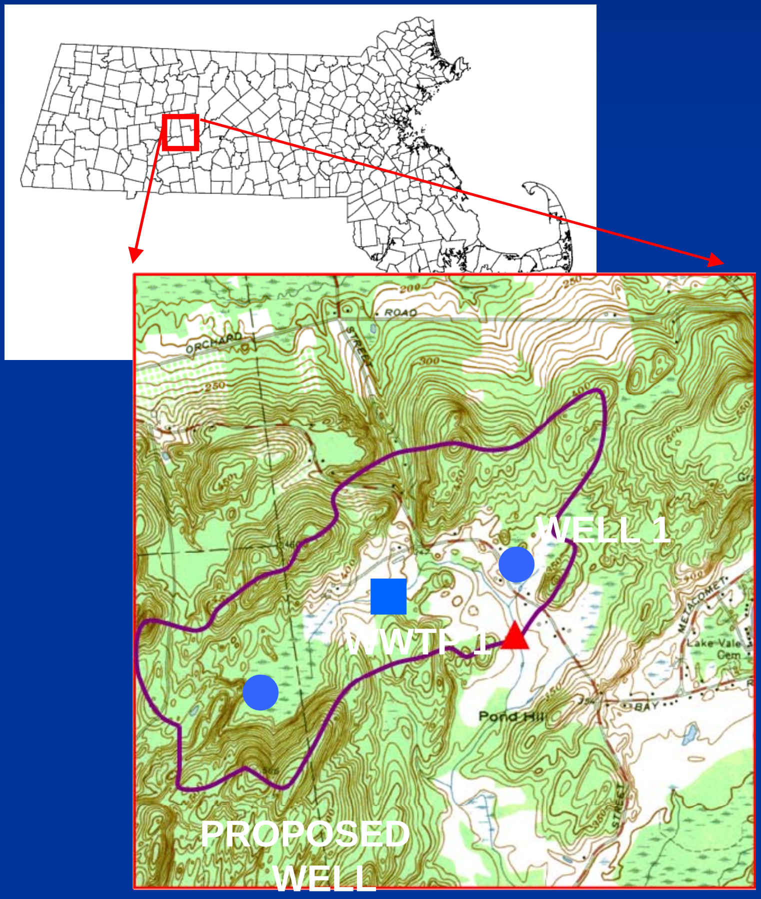

Includes median seasonal flows for fish bioperiods

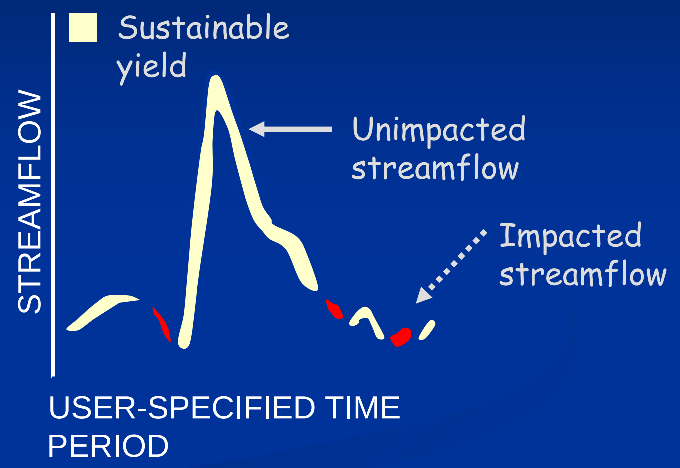


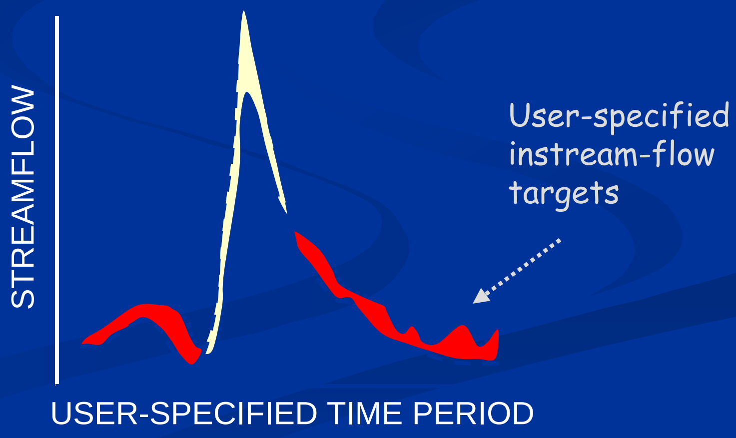

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q75 (daily) | 0.75 | 0.77 | 1.38 | 2.32 | 1.27 | 0.63 | 0.33 | 0.23 | 0.21 | 0.33 | 0.75 | 1.03 |
| Q50 (daily) | 1.13 | 1.17 | 2.46 | 3.54 | 2.00 | 1.01 | 0.52 | 0.38 | 0.38 | 0.70 | 1.38 | 1.62 |
| Q25 (daily) | 1.88 | 2.02 | 4.11 | 5.59 | 3.08 | 1.69 | 0.85 | 0.75 | 0.80 | 1.46 | 2.25 | 2.61 |

2008 MA Index Streamflows Adopted by WRC as → "Reference" flows

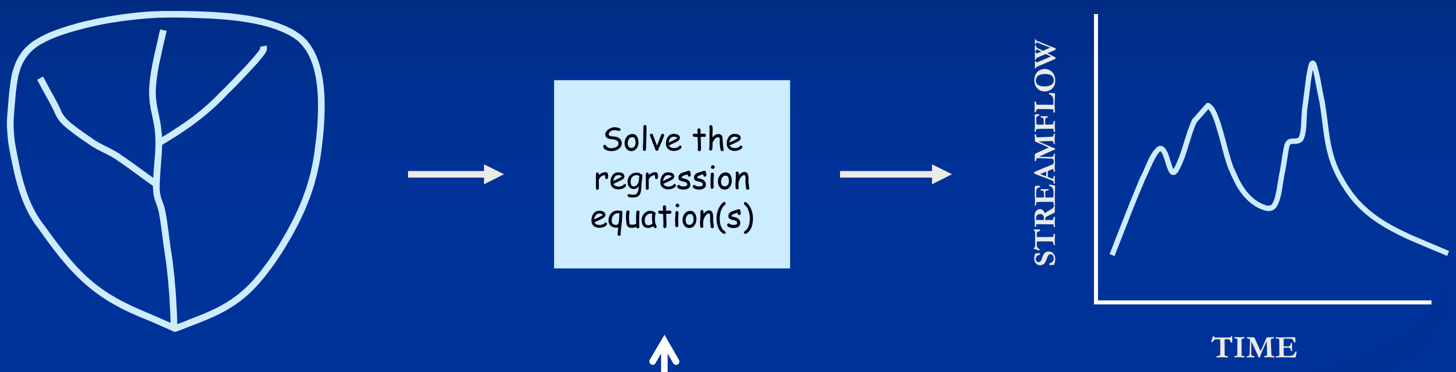
# 2009: USGS/DEP
# Sustainable Yield Estimator Application



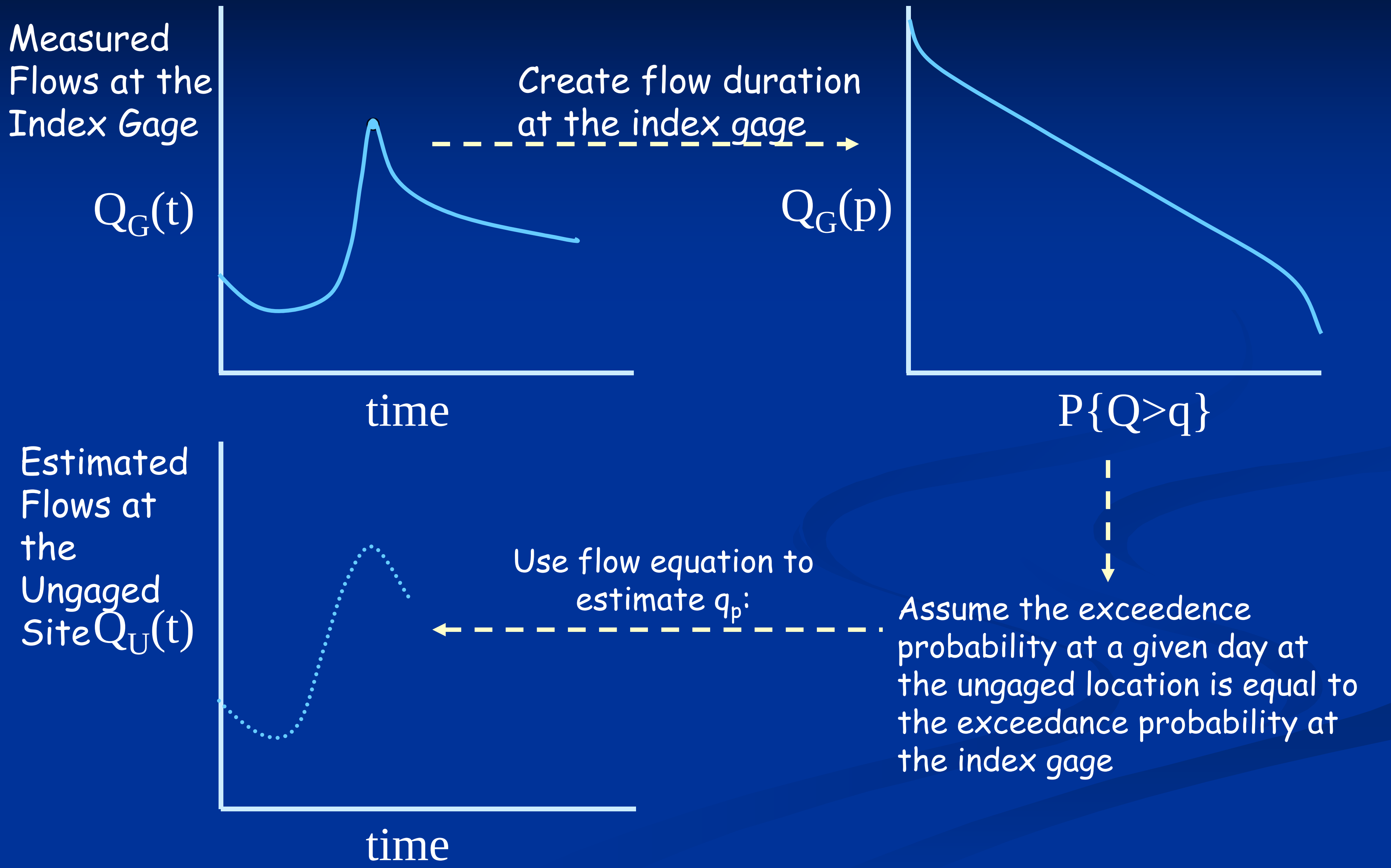
# Estimating the natural-flow regime




Basin characteristics required by regression equations (e.g., basin area, surficial geology, slope)

The 66-index gage data were used for estimating the natural-flow regime at the daily time-scale.

# SYE methodology



# Data Sources for SYE and MWI

- USGS/DCR/DFG MA Index Gages
- DEP Data Bases
  - Water Withdrawal data
  - Water Return (discharge) data
- MAGIS (impervious cover)
- DCR Office of Dam Safety Data Base
- ACOE National Inventory of Dams
- DEP/EPA 303(d) List of Impaired Waters

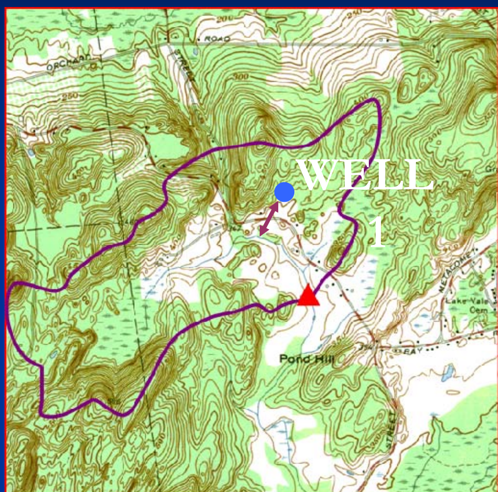
SYE

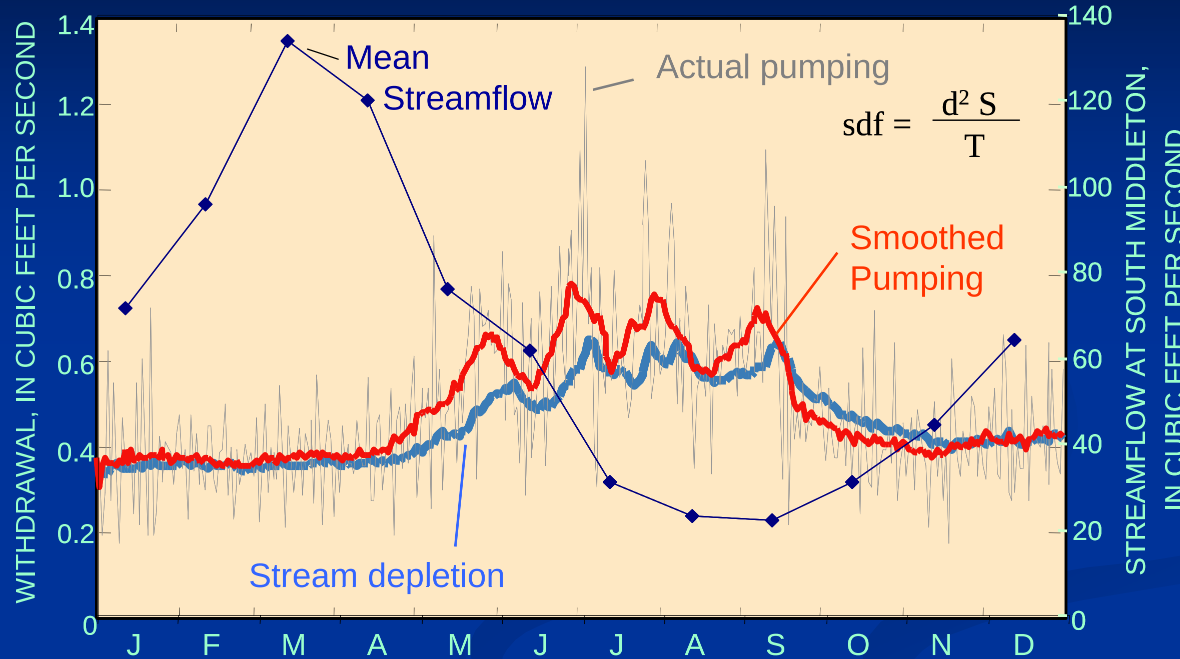
MWI

# SYE Limitations

- Cannot estimate impacts of surface water reservoir withdrawals
  - Would require detailed information about reservoir/dam physical parameters and operation
- Assumes instantaneous ground water withdrawal/surface water impact

# StreamDeplete Estimates Well Pumping Impacts on Streamflow




STRMDEPL is an analytical solution to calculate time-varying streamflow depletion due to a pumping well

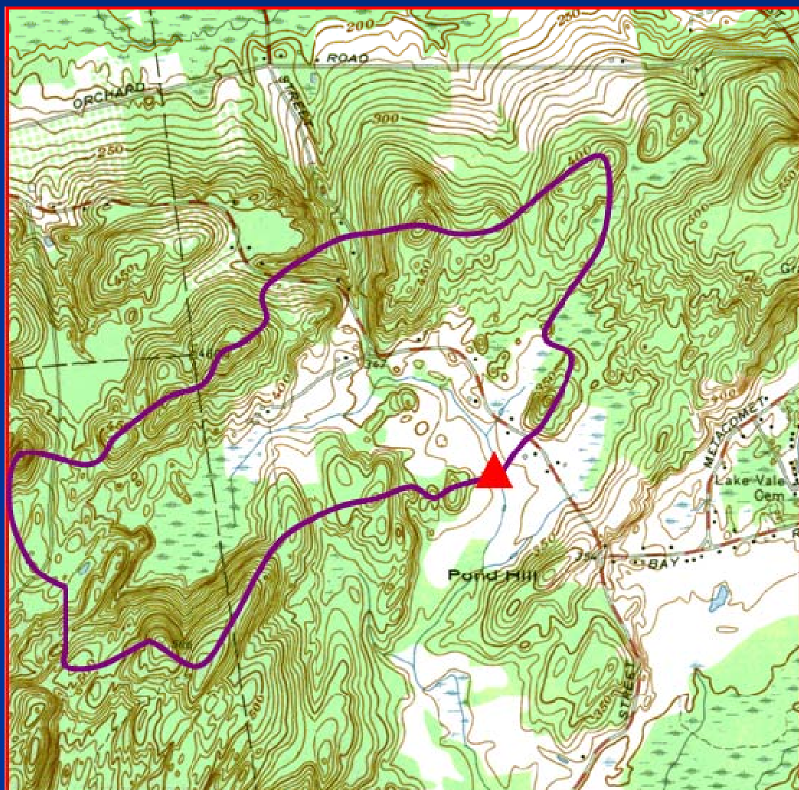
To calculate streamflow depletion, the equations require:

1. The perpendicular distance from the well to the stream (*d*)
2. The ratio of the aquifer's specific yield (*S*) to the aquifer's transmissivity (*T*)

*Source:* Zarriello, P.J. and Barlow, P.M. (2000)

*Site shown: Wenham well, DEP No 3119-000-05G & 3119000-06G 300 & 720 feet from stream, respectively*

# Application Demonstration: Specify instream-flow targets




## Menu of instream-flow targets

Percent of Index Streamflow:

Pre-defined Target 1:

Pre-defined Target 2:

Pre-defined Target 3:

Custom-defined Targets:

## Custom-defined instream-flow targets

January:

February:

March:

April:

May:

June:

July:

August:

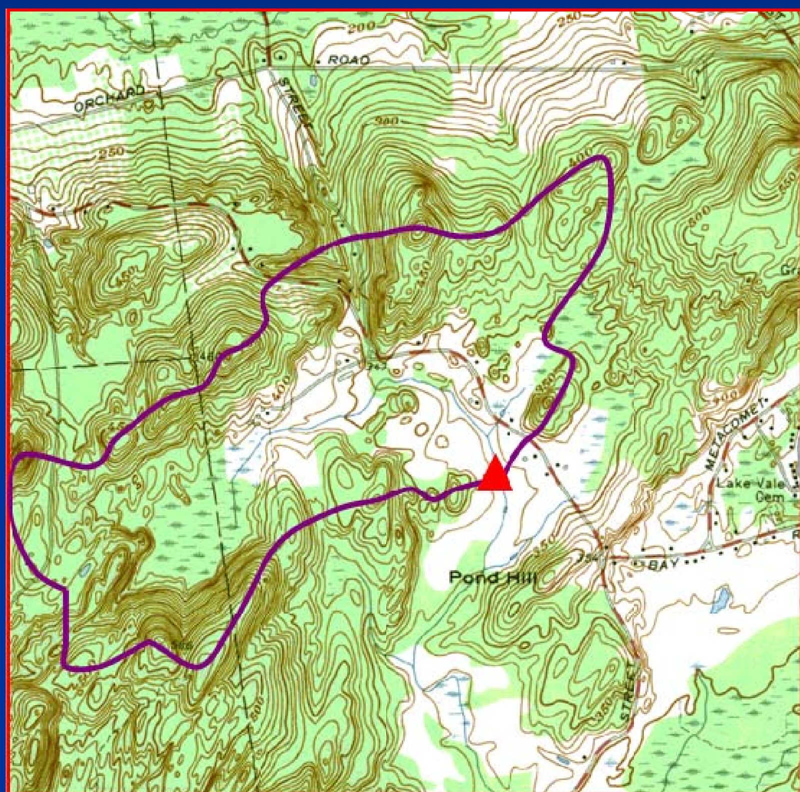
September:

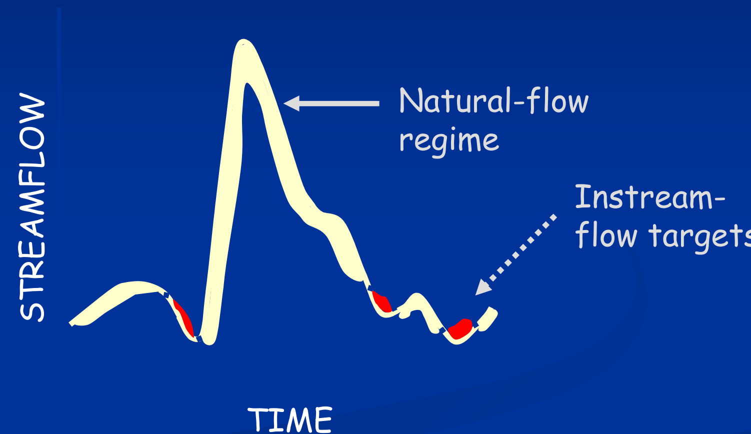
October:

November:

December

# Application Demonstration:
# Specify instream-flow targets

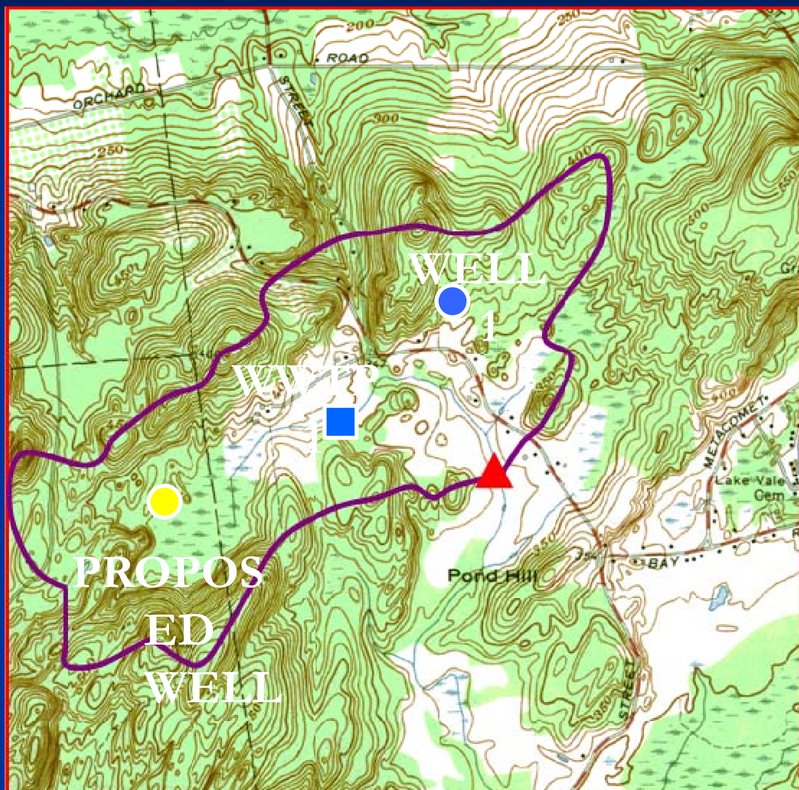



Adjust instream-flow targets?

YES NO

# Application Demonstration:
# Specify point withdrawals and discharges




Run simulation with existing withdrawals and returns?

YES ☐ NO ☐

## Edit Basin Withdrawals/Returns

SITE NAME: **Well 1**

Withdrawal ☒ X

Return flow ☐

| | | | |
|---|---|---|---|
| January: | | July: | |
| February: | | August: | |
| March: | | September: | |
| April: | | October: | |
| May: | | November: | |
| June: | | December | |

## Add Basin Withdrawal/Return

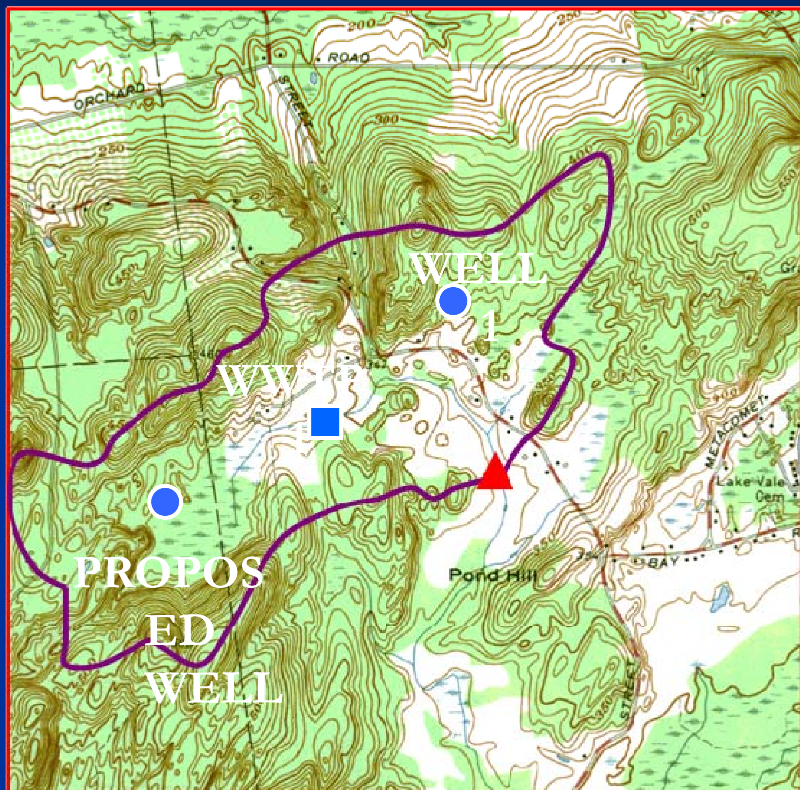
SITE NAME: **Proposed Well**

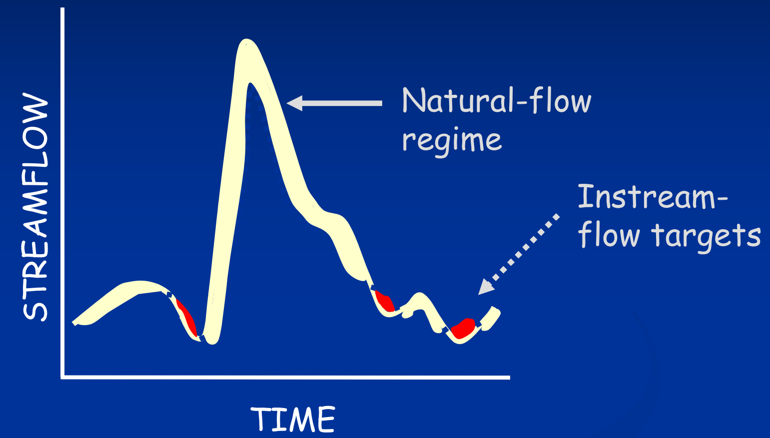
Withdrawal ☒ X

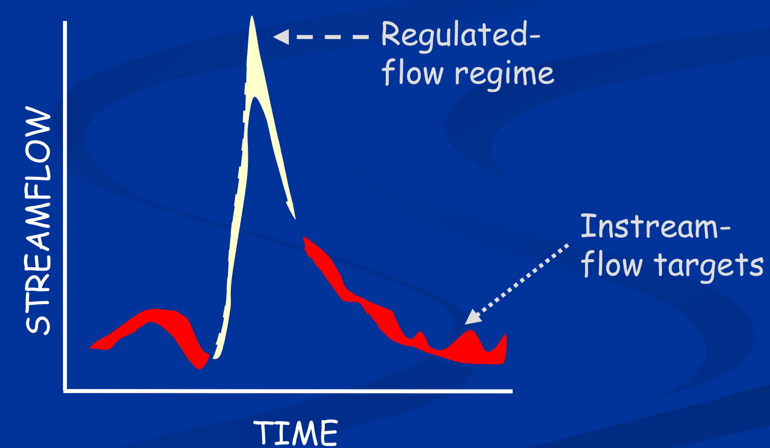
Return flow ☐

| | | | |
|---|---|---|---|
| January: | | July: | |
| February: | | August: | |
| March: | | September: | |
| April: | | October: | |
| May: | | November: | |
| June: | | December | |

# Application Demonstration: Estimate regulated streamflow



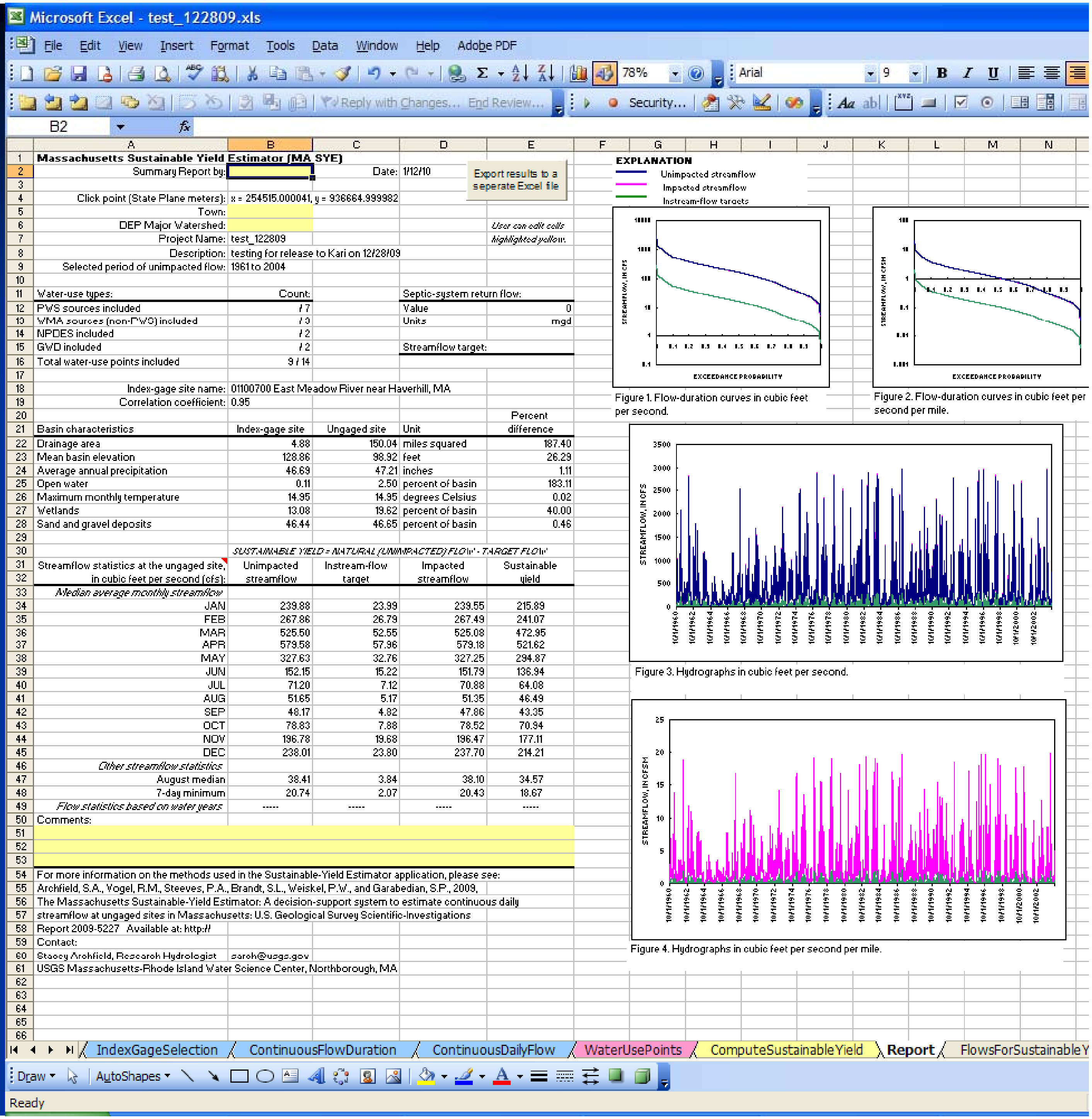

Adjust instream-flow targets, point withdrawals, and/or return flows?

YES

NO

# Results

Results are summarized for the user in a printable 2-page form



# SYE
# Application for Safe Yield

# **Basin Yield**

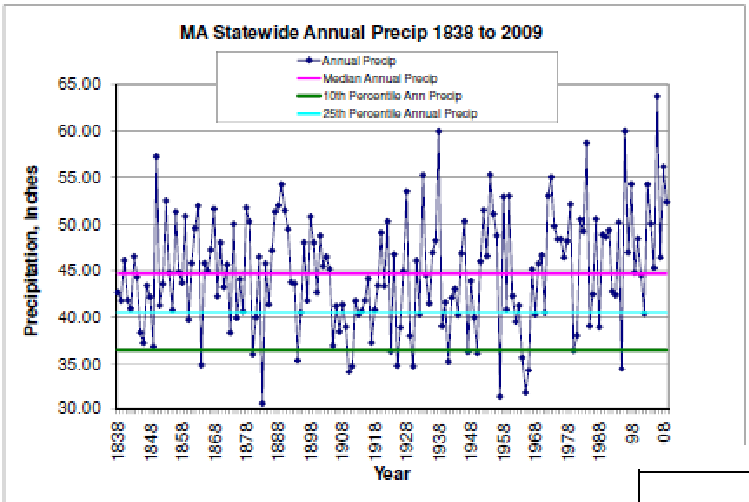
## Annual Drought Volume
## Calculated from SYE Statistics
## using Monthly 90$^{th}$ percentile low flows

| Millers | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
| Q98 | 0.24 | 0.34 | 0.56 | 0.92 | 0.44 | 0.21 | 0.14 | 0.09 | 0.08 | 0.16 | 0.22 | 0.27 | 0.31 |
| Q95 | 0.34 | 0.43 | 0.74 | 1.05 | 0.54 | 0.25 | 0.16 | 0.14 | 0.12 | 0.20 | 0.26 | 0.40 | 0.38 |
| **Q90** | **0.44** | **0.57** | **0.91** | **1.28** | **0.70** | **0.30** | **0.20** | **0.15** | **0.15** | **0.23** | **0.34** | **0.48** | **0.48** |
| Q80 | 0.62 | 0.72 | 1.16 | 1.72 | 0.98 | 0.40 | 0.25 | 0.20 | 0.21 | 0.31 | 0.51 | 0.63 | 0.64 |
| Q75 | 0.70 | 0.80 | 1.32 | 1.93 | 1.11 | 0.46 | 0.26 | 0.22 | 0.22 | 0.34 | 0.58 | 0.73 | 0.72 |
| Q50 (Medians of Daily Means) | 1.11 | 1.23 | 2.24 | 2.95 | 1.63 | 0.84 | 0.39 | 0.33 | 0.33 | 0.53 | 1.11 | 1.29 | 1.16 |
| Median of Monthly Means, cfsm | 1.54 | 1.49 | 2.94 | 4.11 | 2.06 | 1.02 | 0.56 | 0.40 | 0.46 | 0.66 | 1.31 | 1.54 | 1.50 |

Monthly values are time-weighted and "rolled up" into an average annual value *

* =((Jan x 31 days) + (Feb x 28 days) + (Mar x 31 days) + (Apr x 30 days) + (May x 31 days) + (Jun x 30 days) + (Jul x 31 days) + (Aug x 31 days) + (Sep x 30 days) + (Oct x 31 days) + (Nov x 30 days) + (Dec x 31 days) )/365 days

# Precip Records: 1965 was generally the dryest year in MA that we also have Streamflow Record




| Year | State Ann. Precip In. | %normal | Rank | Exceedance Probability % | Recurrence Interval (yrs) |
|---|---|---|---|---|---|
| 1883 | 30.54 | 68 | 1 | 99.4 | 173.0 |
| 1957 | 31.28 | 70 | 2 | 98.8 | 86.5 |
| 1965 | 31.70 | 71 | 3 | 98.3 | 57.7 |
| 1910 | 33.97 | 76 | 4 | 97.7 | 43.3 |
| 1966 | 34.26 | 77 | 5 | 97.1 | 34.6 |
| 1995 | 34.46 | 77 | 6 | 96.5 | 28.8 |
| 1911 | 34.73 | 78 | 7 | 95.9 | 24.7 |
| 1930 | 34.74 | 78 | 8 | 95.3 | 21.6 |
| 1925 | 34.82 | 78 | 9 | 94.8 | 19.2 |
| 1864 | 34.86 | 78 | 10 | 94.2 | 17.3 |

# Monthly Q90 Rollup:

A synthesized low-flow year.

How does it compare to real years?

What is the recurrence interval?

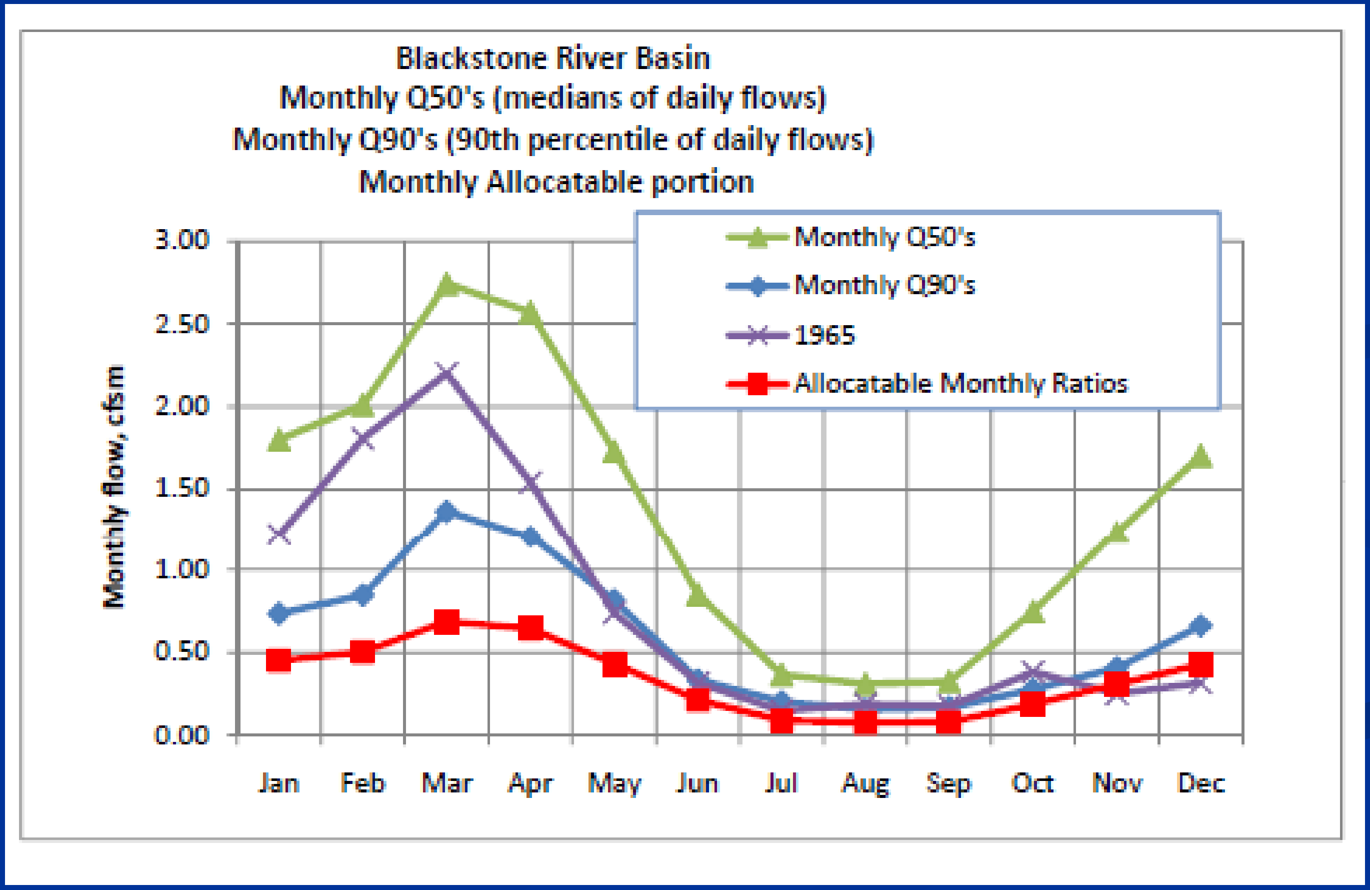
## We compared all the SYE Simulated Years

| | Monthly Median of Daily Mean Flows, cfsm | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
| 1961 | 0.88 | 0.88 | 3.52 | 6.13 | 2.52 | 1.04 | 0.53 | 0.31 | 0.41 | 0.45 | 0.89 | 0.95 | 1.54 |
| 1962 | 1.76 | 0.95 | 2.02 | 4.58 | 1.88 | 0.65 | 0.24 | 0.28 | 0.17 | 0.99 | 2.73 | 2.11 | 1.53 |
| 1963 | 1.70 | 1.16 | 2.59 | 2.24 | 1.60 | 0.79 | 0.20 | 0.10 | 0.06 | 0.06 | 1.33 | 1.52 | 1.11 |
| 1964 | 1.29 | 1.72 | 2.98 | 2.66 | 1.60 | 0.52 | 0.46 | 0.06 | 0.04 | 0.12 | 0.15 | 0.39 | 1.00 |
| 1965 | 0.44 | 1.12 | 1.52 | 1.72 | 0.93 | 0.45 | 0.12 | 0.14 | 0.15 | 0.21 | 0.28 | 0.27 | 0.61 |
| 1966 | 0.33 | 1.17 | 2.72 | 1.23 | 1.00 | 0.46 | 0.12 | 0.10 | 0.17 | 0.26 | 0.73 | 0.61 | 0.74 |
| 1967 | 0.81 | 0.68 | 1.83 | 3.90 | 2.97 | 1.38 | 0.61 | 0.30 | 0.21 | 0.25 | 0.86 | 1.15 | 1.23 |
| 1968 | 1.34 | 1.25 | 2.97 | 1.66 | 1.07 | 1.80 | 0.67 | 0.20 | 0.12 | 0.35 | 1.44 | 1.63 | 1.21 |
| 1969 | 1.31 | 1.56 | 2.22 | 3.89 | 1.52 | 0.57 | 0.22 | 0.24 | 0.21 | 0.28 | 2.33 | 2.71 | 1.42 |
| 1970 | 1.58 | 2.39 | 1.60 | 2.70 | 1.70 | 0.93 | 0.57 | 0.14 | 0.15 | 0.30 | 1.29 | 1.02 | 1.19 |
| 1971 | 0.78 | 1.82 | 3.54 | 3.29 | 2.57 | 0.99 | 0.33 | 0.10 | 0.14 | 0.24 | 0.41 | 1.68 | 1.32 |
| 1972 | 1.25 | 1.53 | 4.20 | 3.70 | 2.57 | 3.31 | 1.96 | 0.33 | 0.55 | 0.62 | 2.38 | 2.56 | 2.08 |
| 1973 | 2.44 | 2.15 | 3.28 | 4.78 | 3.17 | 1.09 | 0.84 | 0.26 | 0.13 | 0.14 | 0.85 | 1.96 | 1.74 |

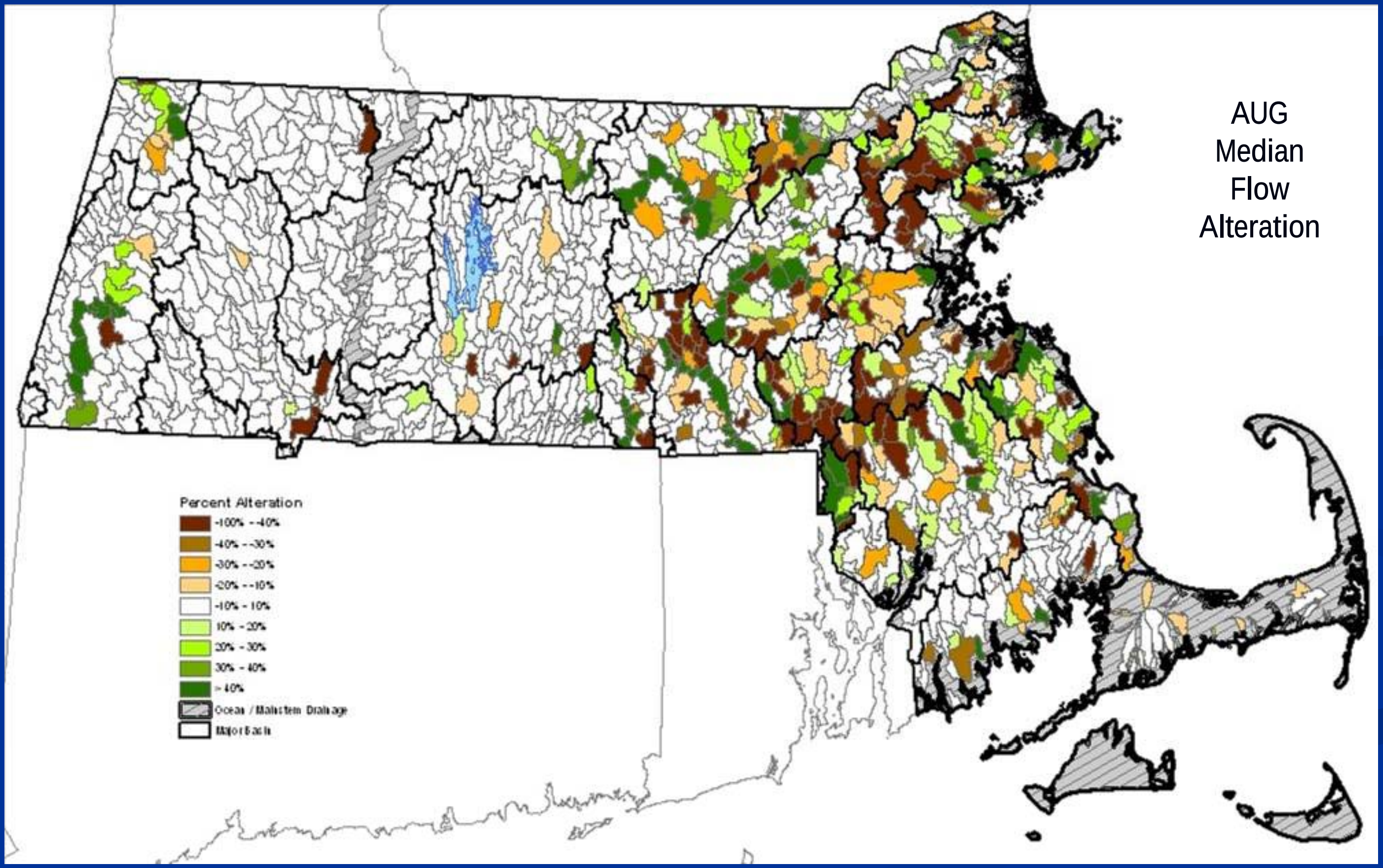
# Monthly Q90 Rollup:

A synthesized low-flow year.

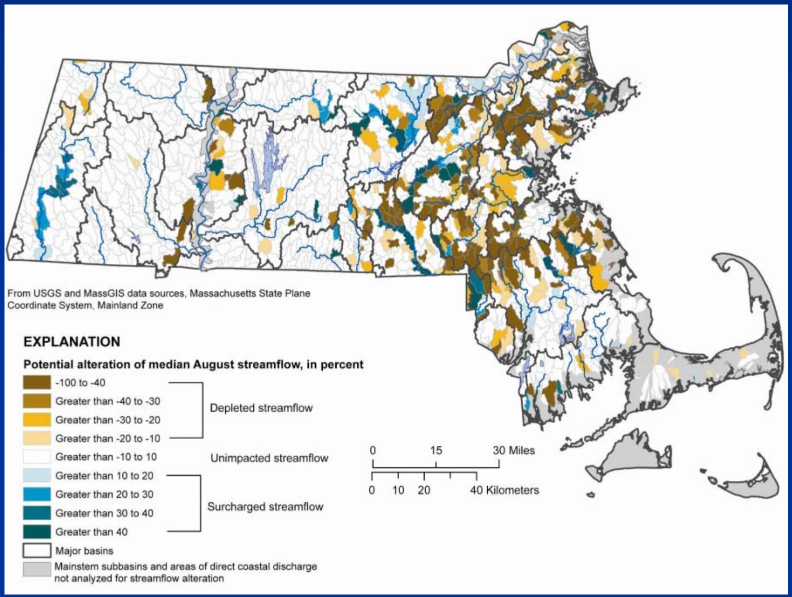
How does it compare to real years?



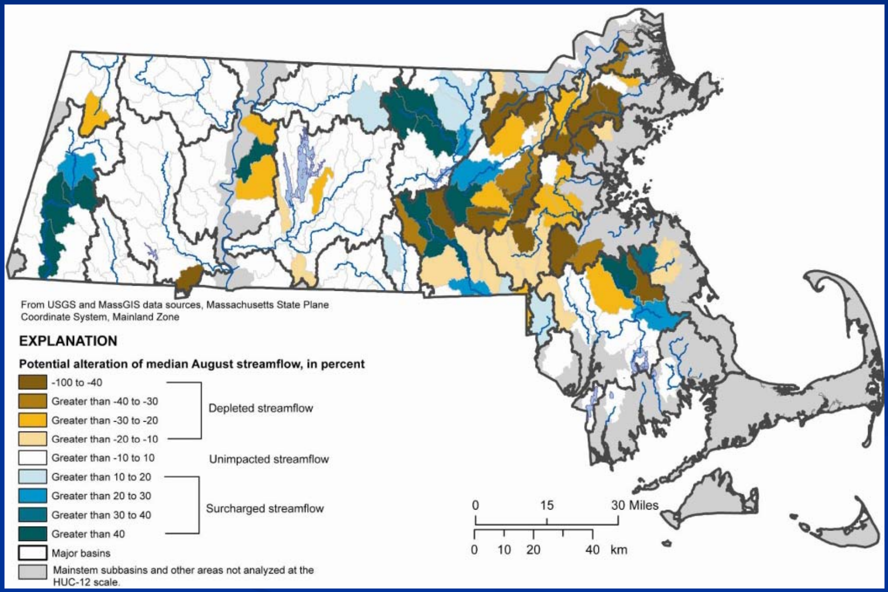
# 2009 Indicators of Streamflow Alteration, Habitat Fragmentation, Impervious Cover and Water Quality for Massachusetts stream basins



# Two static sets of subbasins analyzed by SYE in "batch" mode

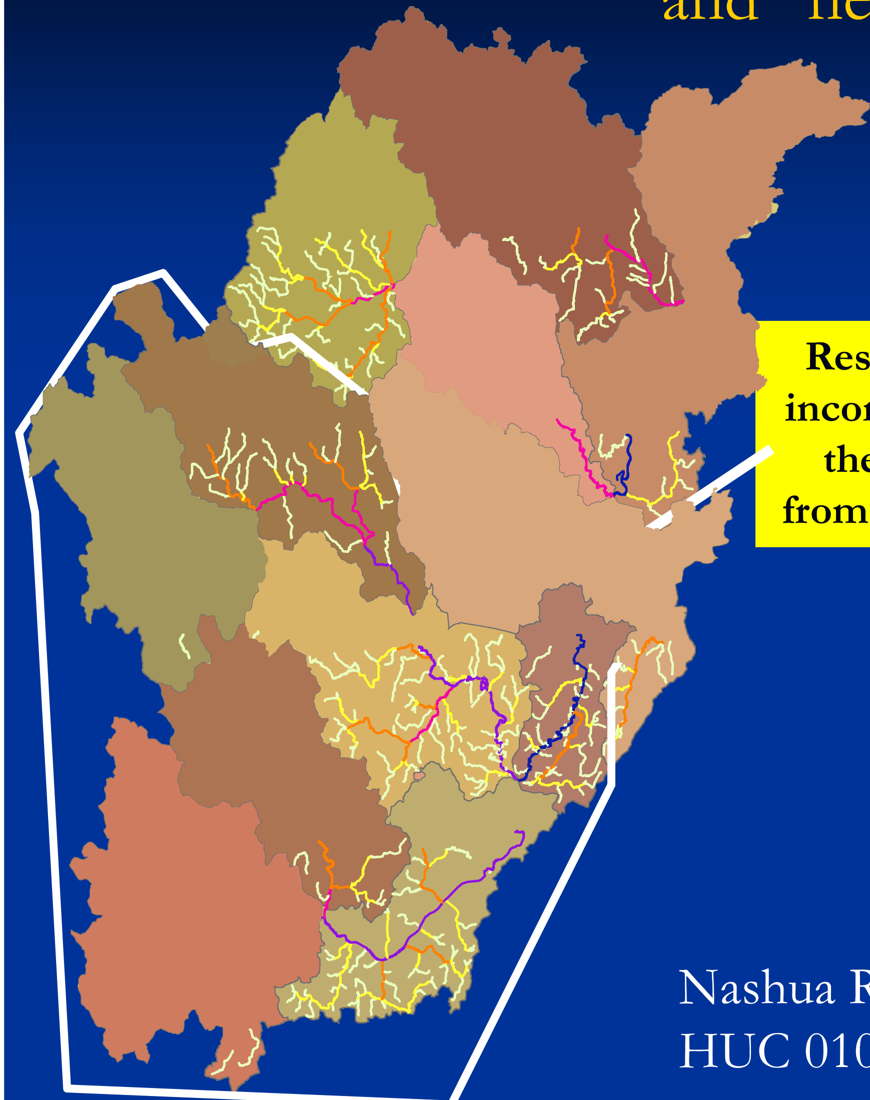



1,429 small subbasins



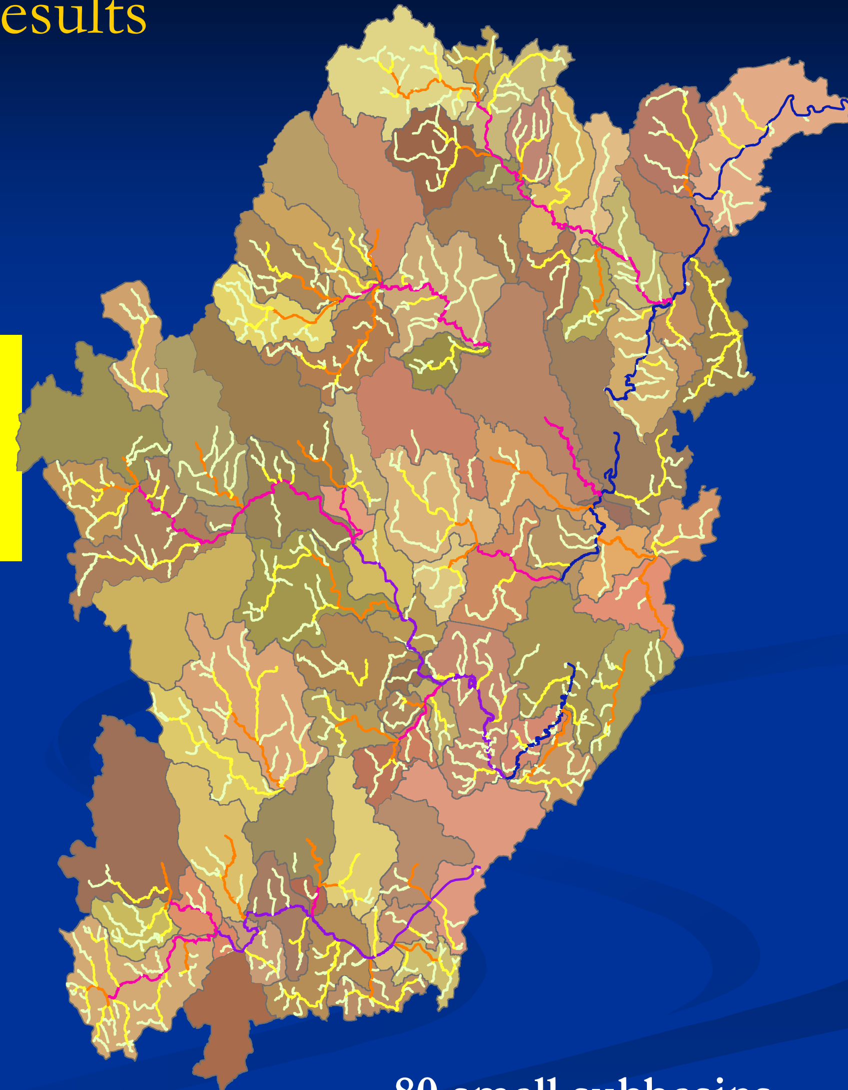

183 HUC-12's
(Hydrologic Unit Code)

# Subbasin delineation and "nested" results



12 HUC-12s

**Results here incorporate all the effects from upstream**



80 small subbasins

Nashua River
HUC 01070004

# MWI Enhancements to SYE

- Estimated effects of private well withdrawals and septic system returns
- Applied a seasonal withdrawal curve to annual withdrawal values
- Used ground water models for areas of Cape Cod and Plymouth Carver Aquifer with fresh water river discharges

# Hydrology--Quantity
# Flow Alteration Indicators

- USGS I/U Percent Alteration
  - Median Jan, Apr, Aug, Oct Flow
  - 7-Day Minimum Flow
  - Low Pulse Duration, Count
- Annual Relative Net Water Demand
- Storage Ratio
- Water Use Intensity

Cover bioperiods,

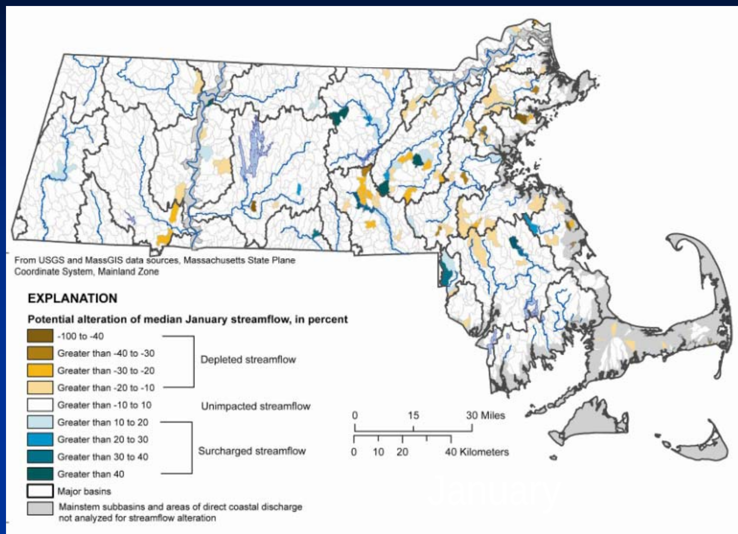
Biologically significant stats

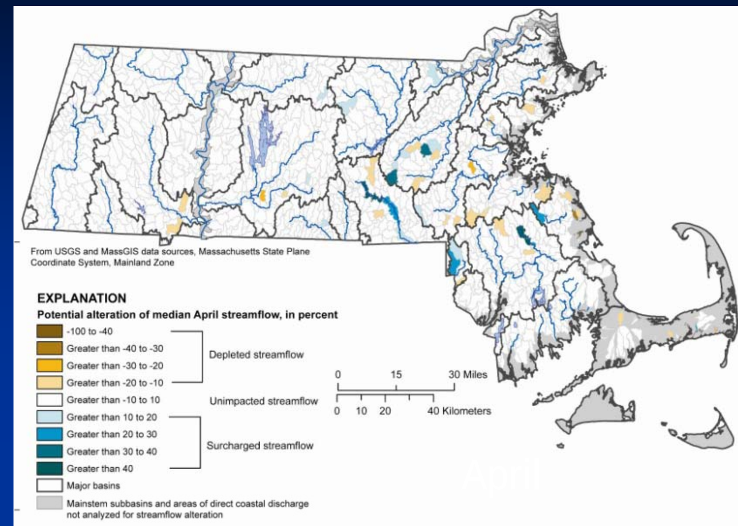
No reservoir SW Withdrawals inc.

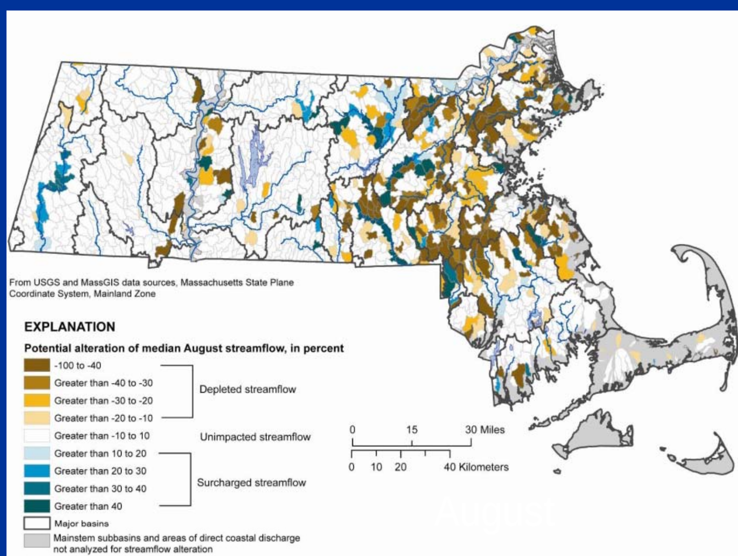
Include reservoir SW Withdrawals

Include non-WS reservoirs

# Monthly Flow Alterations– without surface water withdrawals



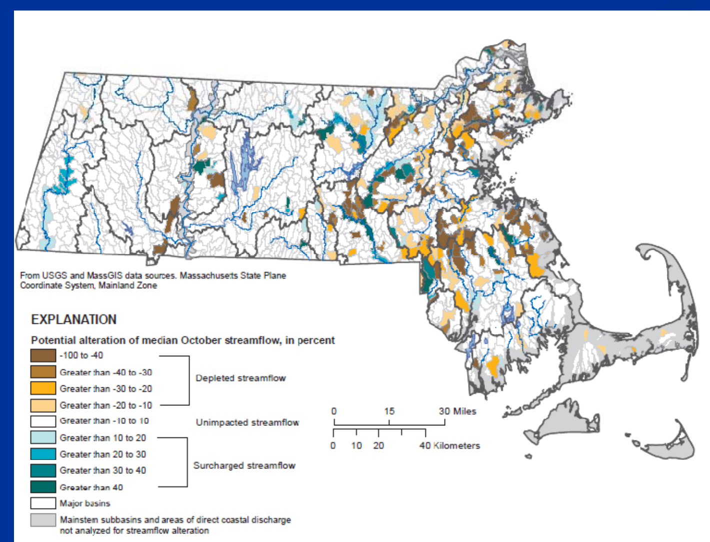
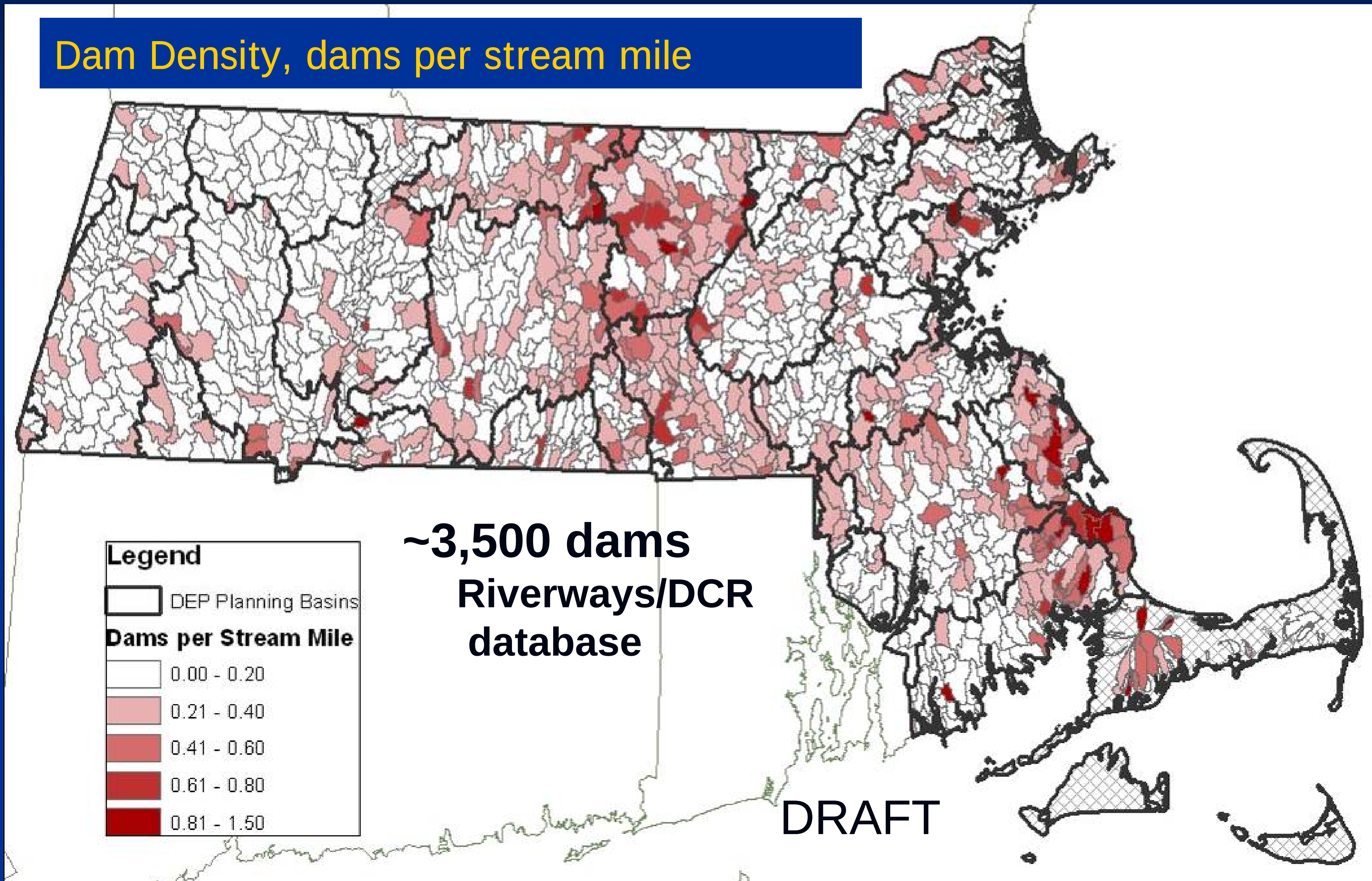
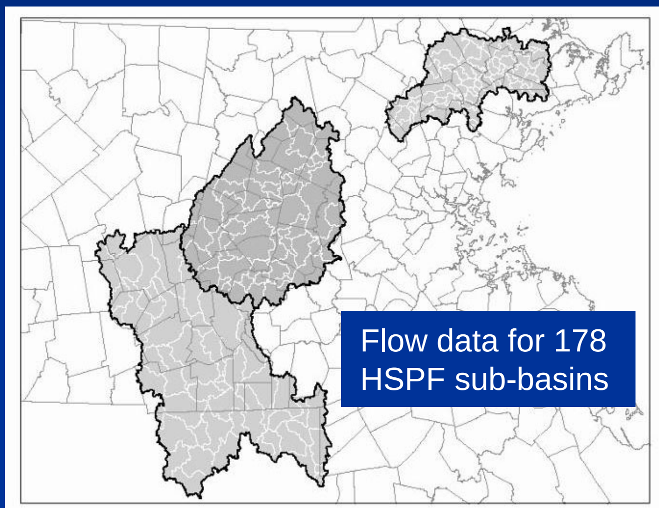




Figure 9. Potential alteration of median October streamflow for 1,420 Massachusetts subbasins and groundwater contributing areas, water-use scenario 1 (no surface-reservoir withdrawals)

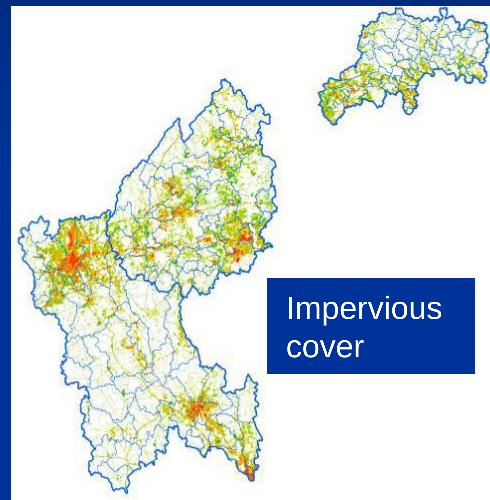
# Habitat Fragmentation Indicator



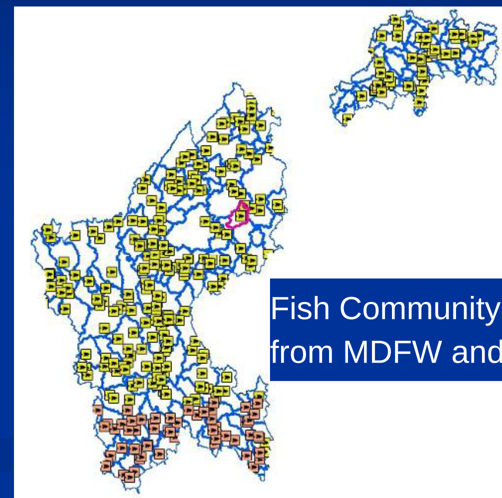
# 2008 Pilot Study of 3 Basins
# Fish community response to flow alteration, land use, and water quality



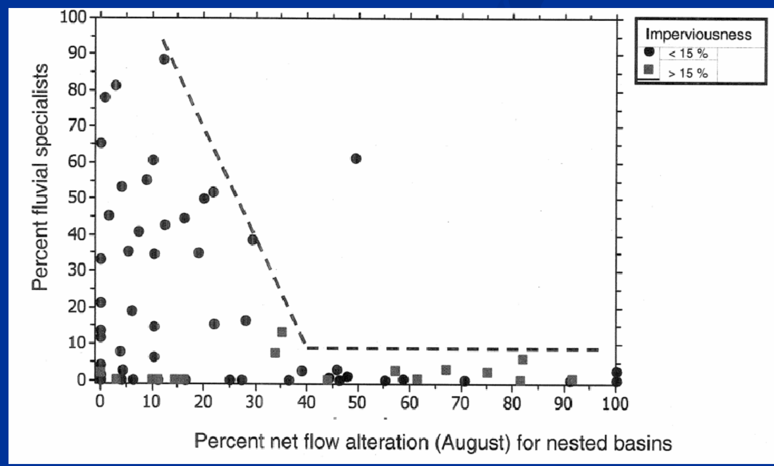
Flow data for 178 HSPF sub-basins



Impervious cover

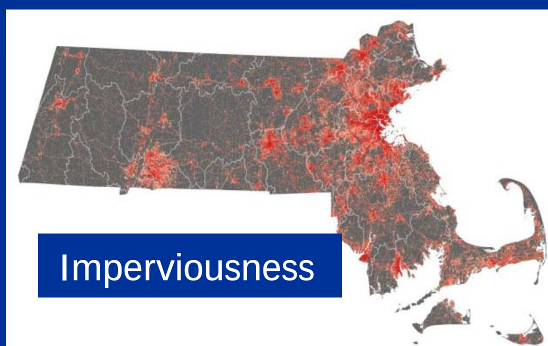


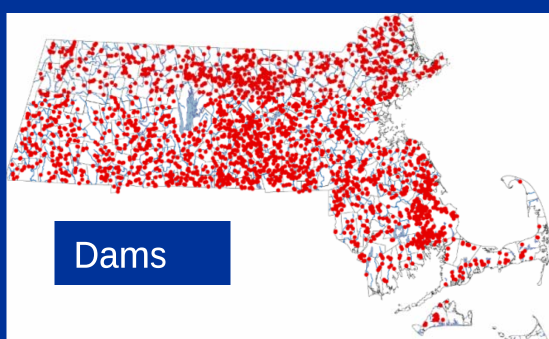
Fish Community data from MDFW and RIDEM



# 2009-2011: Statewide “Fish and Flow Study”

## Fish Community Response to Flow Alterations, Land Use, Impoundments, and Water Quality in Massachusetts



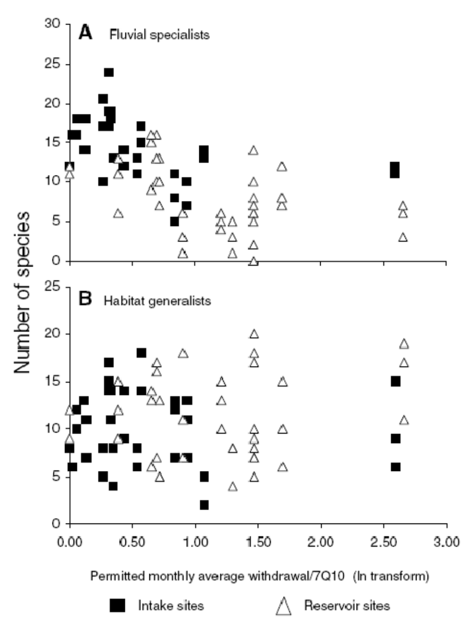
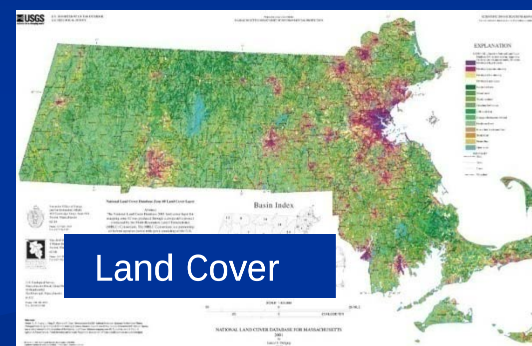
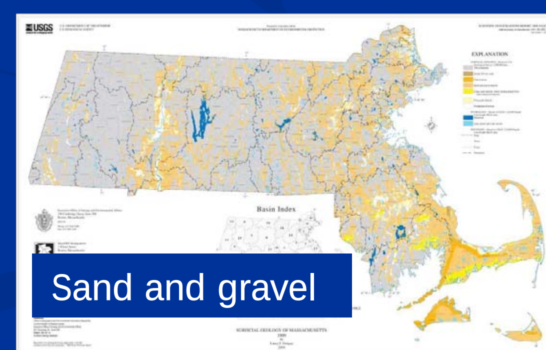




**Figure 5.** Richness estimates for fluvial specialist (**A**) and habitat generalist (**B**) fishes plotted in relation to withdrawal index at intake and reservoir sites, data for all years.



# 2010 Accelerated Fish and Habitat Study

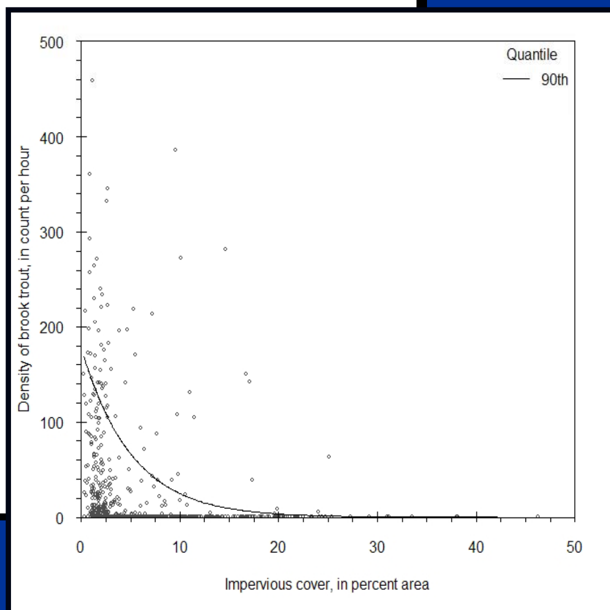

USGS
science for a changing world

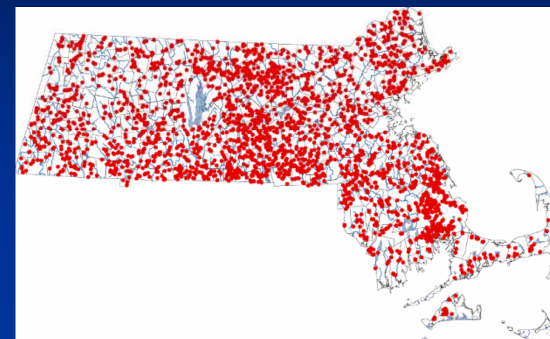
Prepared in cooperation with the
Massachusetts Department of Conservation and Recreation, the
Massachusetts Department of Environmental Protection, and the
Massachusetts Department of Fish and Game

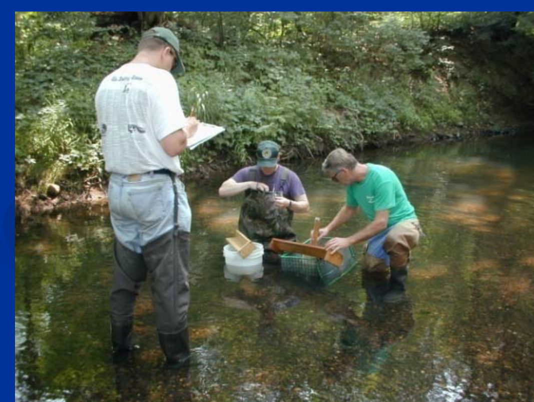
Preliminary Assessment of Factors Influencing
Riverine Fish Communities in Massachusetts

Open-File Report 2010–1139

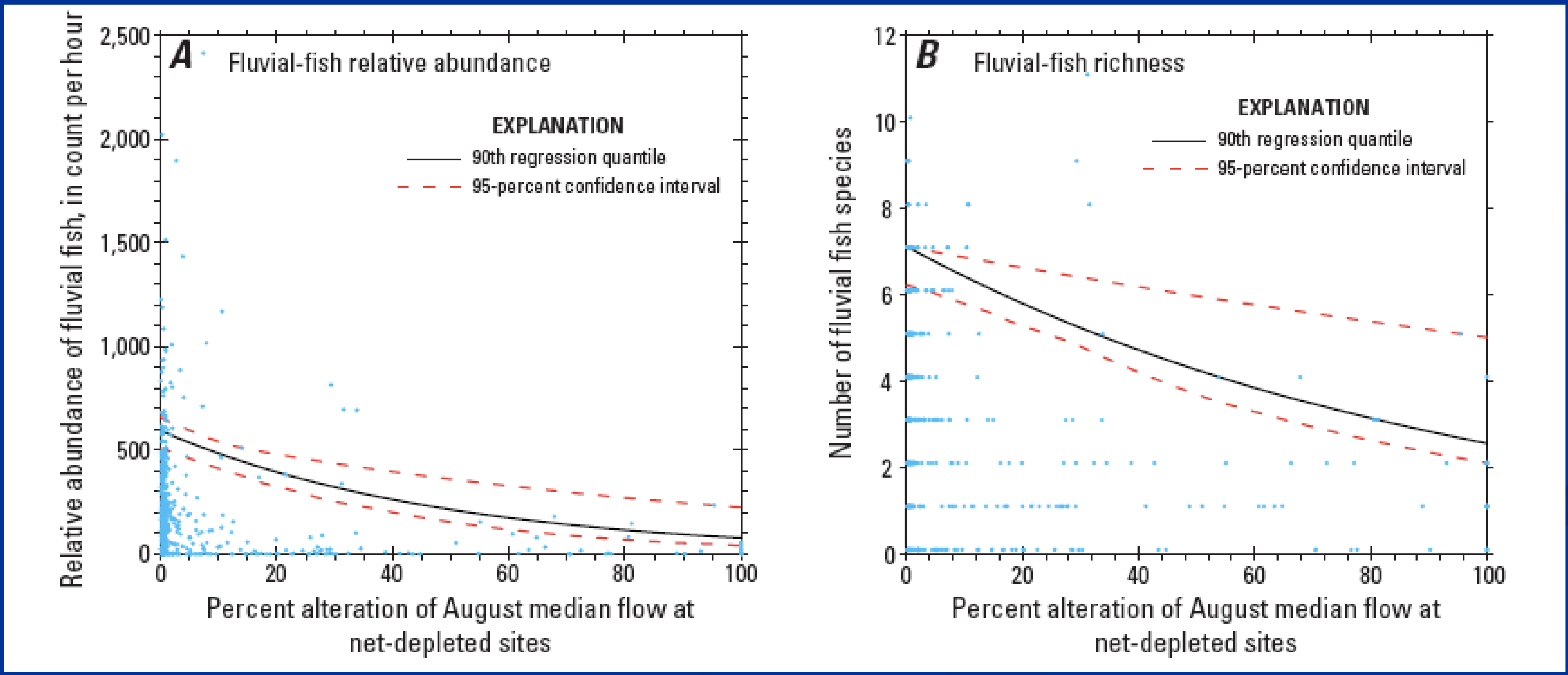
U.S. Department of the Interior
U.S. Geological Survey



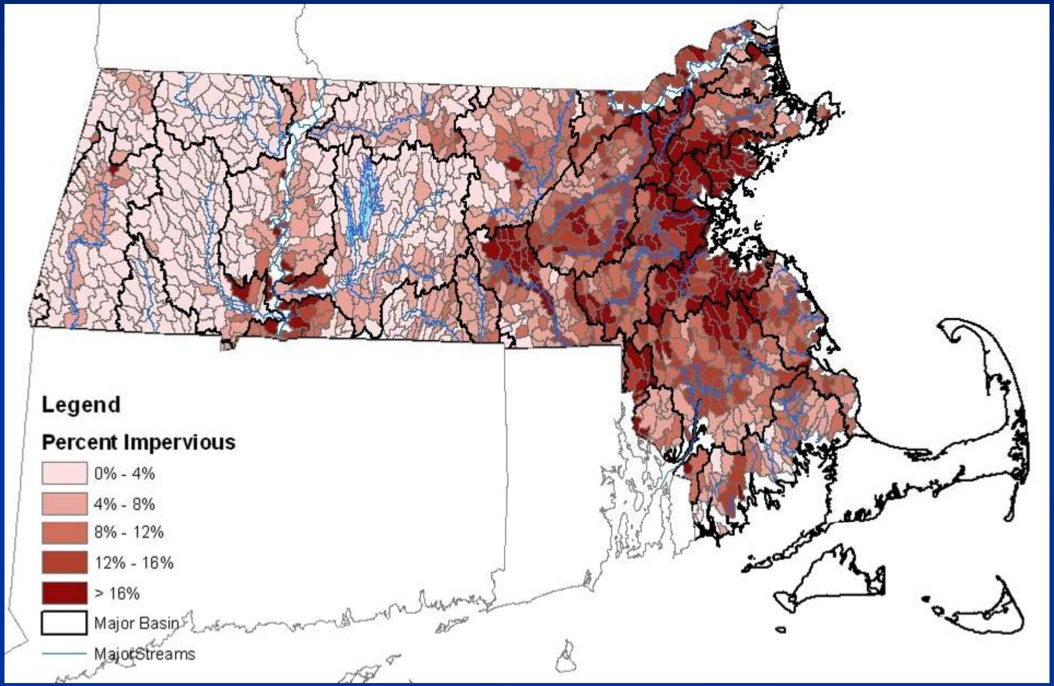



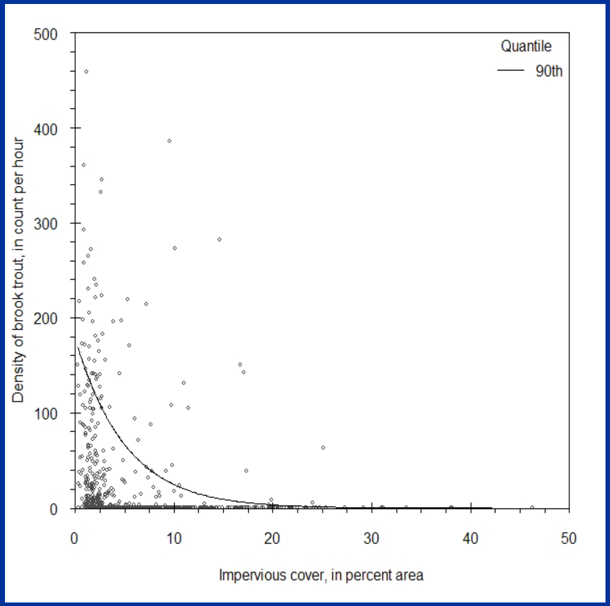


The Preliminary Fish and Flow Study showed that flow depletion and surcharging are associated with decreases in the abundance and diversity of river fish.

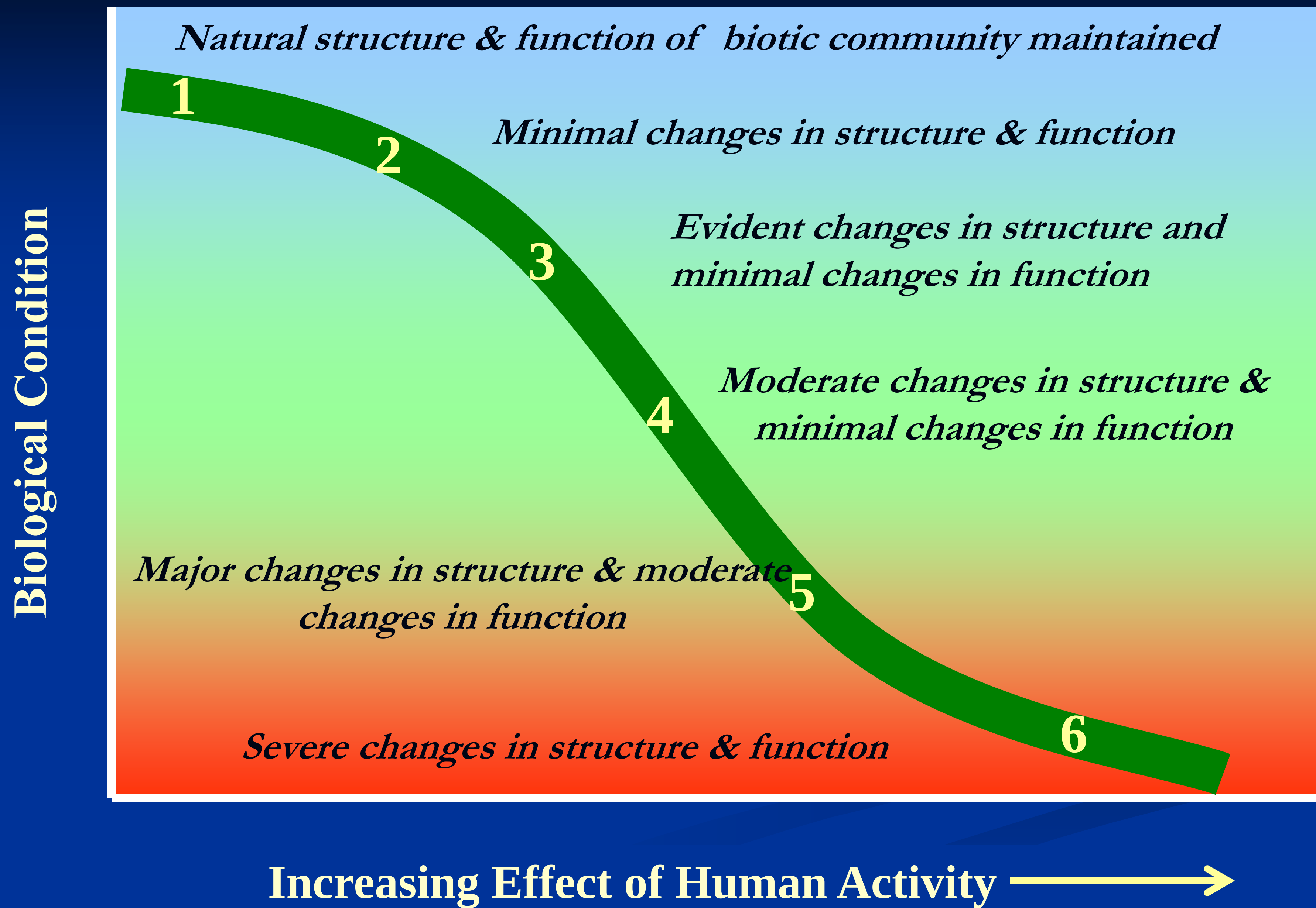


# Impervious Cover: The other smoking gun!

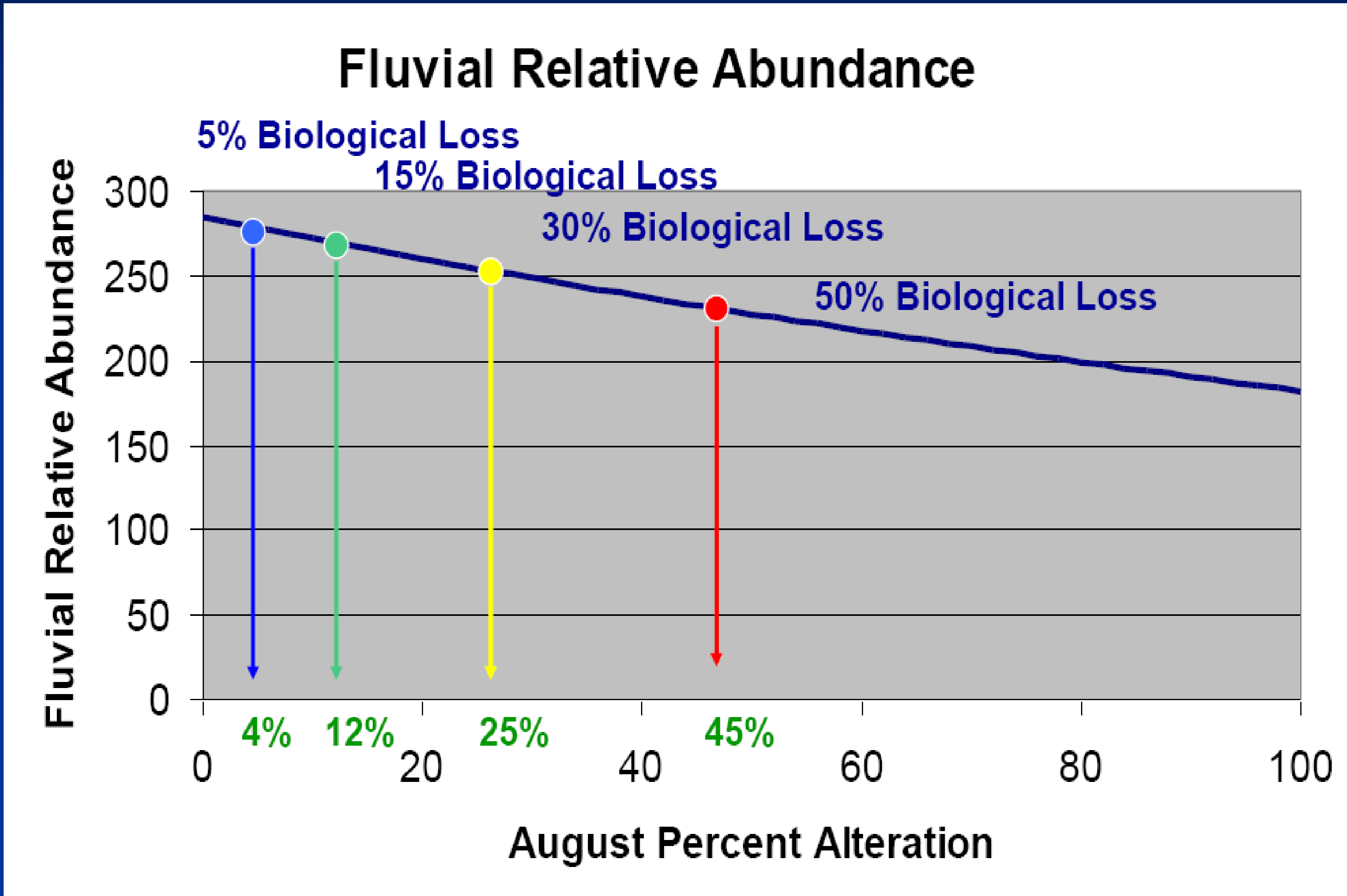



# The Biological Condition Gradient – Concept

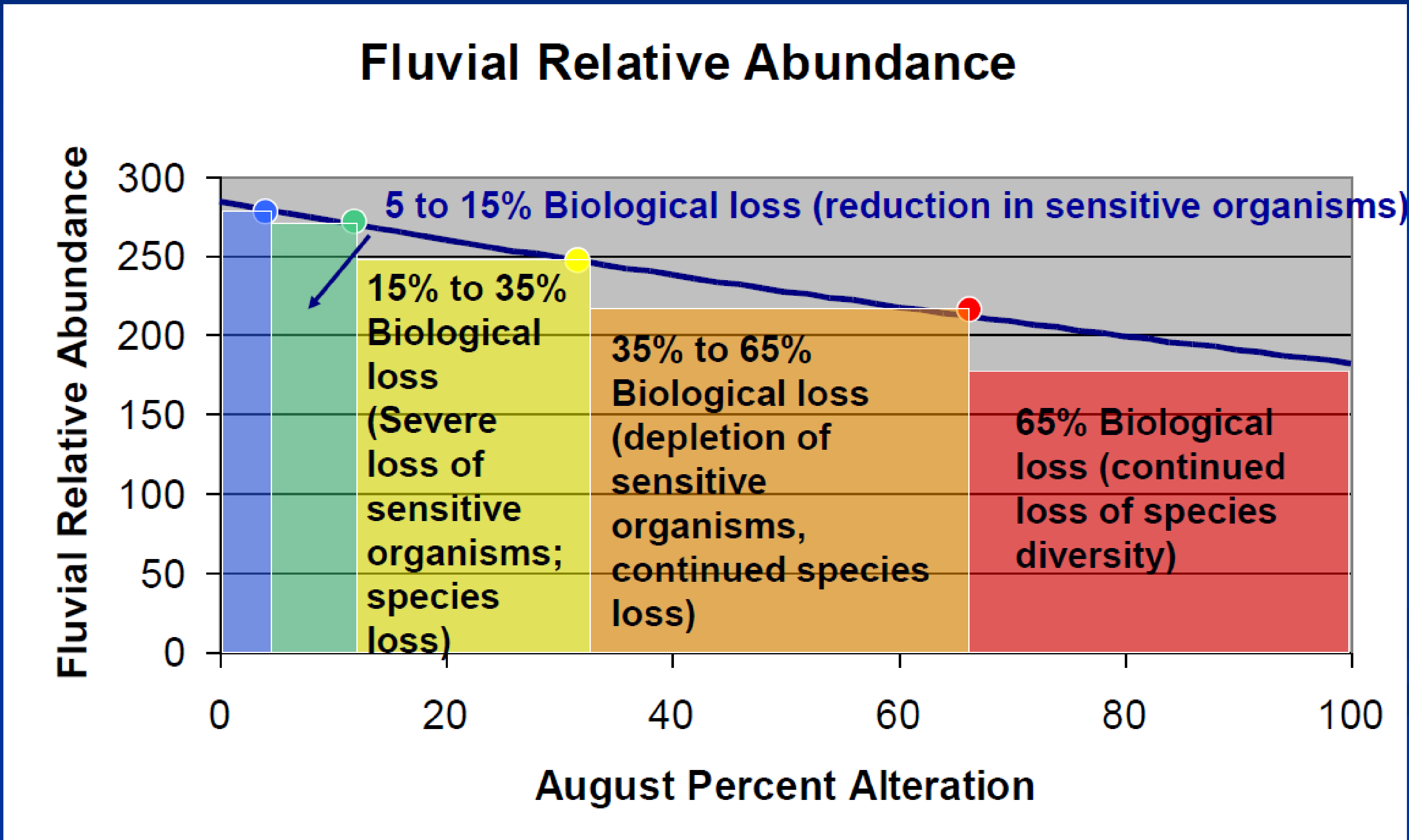


# "Fish & Habitat" Response Curves → River Categorization

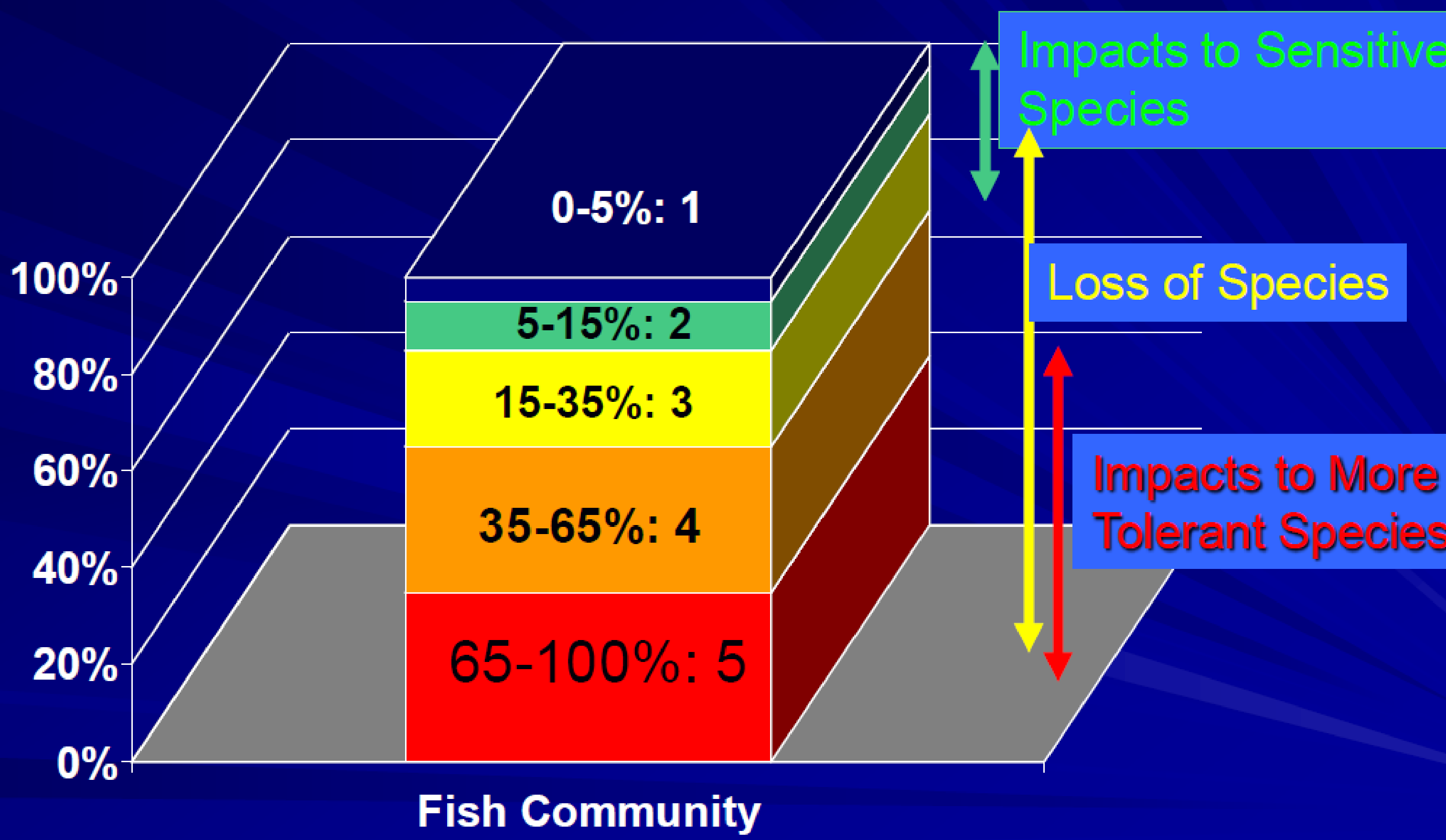


# Biological Categories

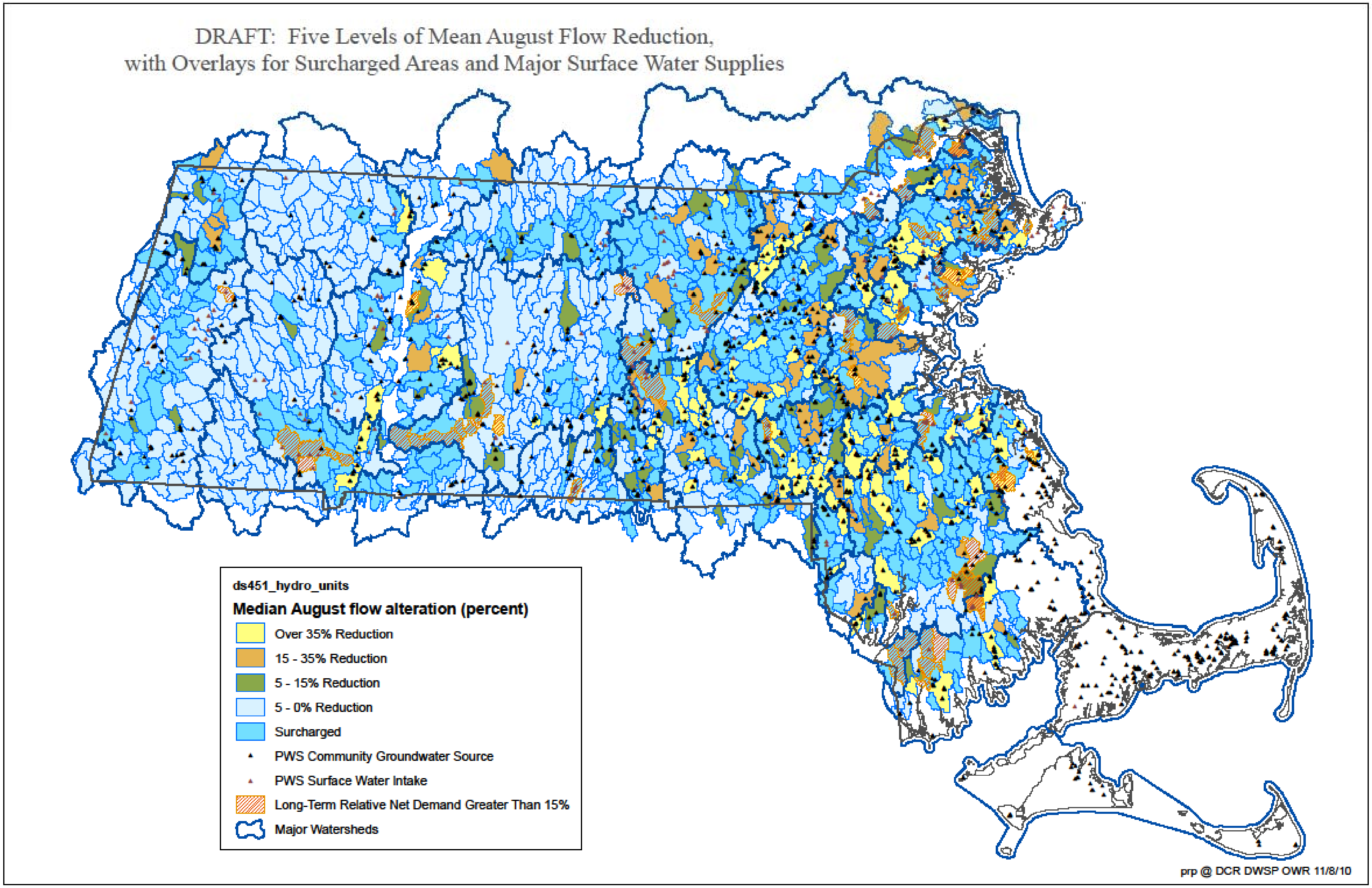
## Curve based on basin characteristics
## for a specific % Percent Impervious cover



# Fish Community Response

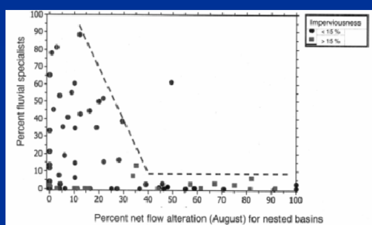


# Streamflow Levels



# Incorporate Streamflow Criteria into an Allocation scheme using Predictable Permitting Decisions

Statewide Fish & Flow Study Results

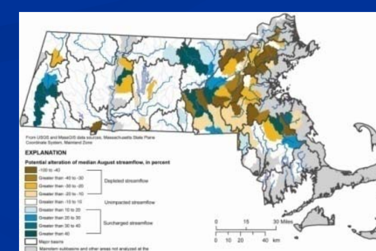




Seasonal Streamflow Criteria

*Set thresholds and limits*

*Compare to*



MA Water Indicator Results

*Apply to*

Allocation/Classification Scheme

Guidelines for Protection/ Mitigation

***Implement through***

WMA Permits + Other Programs?

# Streamflow Criteria
# Water Management Act Permits

| WMA PERMIT REVIEW TIERS | WMA REVIEW THRESHOLDS | FLOW LEVEL TO WHICH REVIEW TIER MAY APPLY | BIOLOGICAL CATEGORY 1 OR COLD WATER FISHERIES RESOURCE (CFR) | MITIGATION |
|---|---|---|---|---|
| Tier 1 | No additional withdrawal request above baseline | August flow levels 1 through 5 | If present, then do a Desktop Pumping Evaluation (DPE) | Conditions 1-8* |
| Tier 2 | Withdrawal request is for:<br>1) withdrawal volume equal to or less than 5%** estimated unaffected Aug median flow and;<br>2) will not result in flow level change; and<br>3) will not result in biological category change | August flow levels 1, 2 and 3 | If present, then consult with agencies (DEP, DFG, DCR) to establish mitigation options, including DPE | Conditions 1-8 *<br>Immediately evaluate additional mitigation options<br>Implement mitigation after first exceedence of baseline |
| Tier 3*** | Withdrawal request is for:<br>1) greater than 5% of estimated unaffected August flow or;<br>2) would result in a change in flow level (up to flow level 3); or<br>3) would result in a change in biological category | August flow levels 1, 2 and 3 | If present, then consult with agencies (DEP, DFG, DCR) to establish mitigation options, including DPE | Conditions 1-8<br>Conduct alternatives analysis must demonstrate no feasible alternative****<br>Consult with agencies to evaluate mitigation options |
| | any additional withdrawal request | August flow levels 4 and 5 | | Implement mitigation options |

**For the purposes of this document, 5% was selected to distinguish large withdrawal requests from smaller withdrawal requests, the additional criteria illustrate that even small requests can cause impacts and result in a tier 3 review.
*** Could result in backsliding
****Water Metrics maps may be considered here (need to determine how)

| Water Supply Related Mitigation | Physical Instream Habitat | Water Quality/Muncipality |
|---|---|---|
| Total ban on non-essential Seasonal Water use | Down stream releases for surface water withdrawals (systems releasing water downstream may operate based on a DEP approved reservoir management plan. Such a plan would allow the PWS to implement water use restrictions based on their plan, not DEP's.)* | Impletment Stormwater Utility |
| Always below 55 RGPCD | | Waterwater Reuse/Return |
| PWS above 65rgpcd: 1 day/week calendar & 0 day/week streamflow trigger | **Connectivity Improvement**<br>a. install fish ladder b. Replace/Resize Identified Culverts<br>c. Dam Removal<br>All pending DFG approval | MS4 requirements for muncipality not subject to requirements |
| Water B[illegible] | | MS4 requirements town-wide where not required town-wide |
| Bylaw prohibiting automatic irrigation systems | | Water Qualtiy and recharge rules that exceed MS4 rules |
| Private Well bylaw controlling irrigation | Restore stream buffers | Require LID in stormwater Bylaw |
| adoption and enforcement of a bylaw to require the installation of moisture sensors or similar climate related control technology on all irrigation systems (RGPCD) | *All Tier 2 & Tier 3 PWS with SW sources will be required to evaluate downstream releases as part of the consultation sessions. | Land acquisition/CR<br>a. stream corridor;<br>b. ecosystem |
| Provide water savings devices (faucet aerators & low shower heads) at cost (RGPCD) | | |
| provide rebates or other incentives for the purchase of low water use appliances (RGPCD) | | |
| PWS always below 65 RGPCD: 2 days/week calendar & 1 day/week streamflow trigger | | I/I Reduction Plan |
| the use of increasing block or seasonal rate structure to increase conservation (RGPCD) | | Mitigation Fund |
| Monthly or quarterly billing (RGPCD & UAW) | | |
| Enterprise account | RED | |
| Stretch Code for Water efficiency (low flow devices, Industrial/Commercial Audits etc) | BLUE | |



Tiered Permit Reviews
Based on Flow Levels
Biological Categories and CWF

Mitigation Menu
Based on Tier
With agency consultation