Water Resources Commission
Commonwealth of Massachusetts

Presentation Title:	Summary Presentation: Preliminary Assessment of Factors Influencing Riverine Fish Communities in Massachusetts
Presented By:	Peter K. Weiskel U. S. Geological Survey
Date of Presentation:	18 November 2010

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Preliminary Assessment of Factors Influencing Riverine Fish Communities in Massachusetts

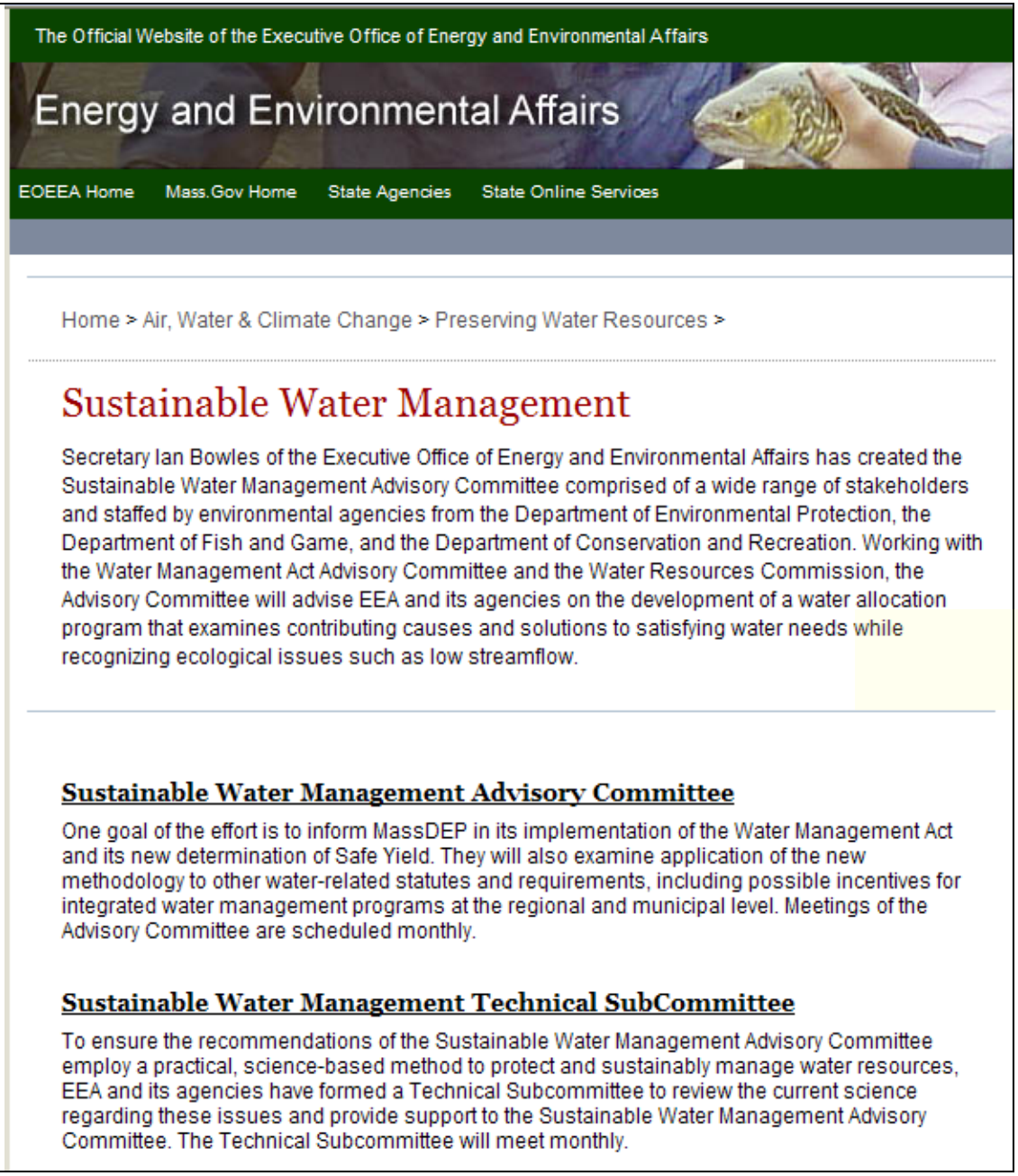
Peter K. Weiskel
U.S. Geological Survey

in cooperation with the
Massachusetts Dept. of Conservation and Recreation
Massachusetts Dept. of Environmental Protection
Massachusetts Dept. of Fish & Game

Mass. Water Resources Commission
November 18, 2010

USGS
science for a changing world

3 USGS projects are being used for development of a new flow policy in MA



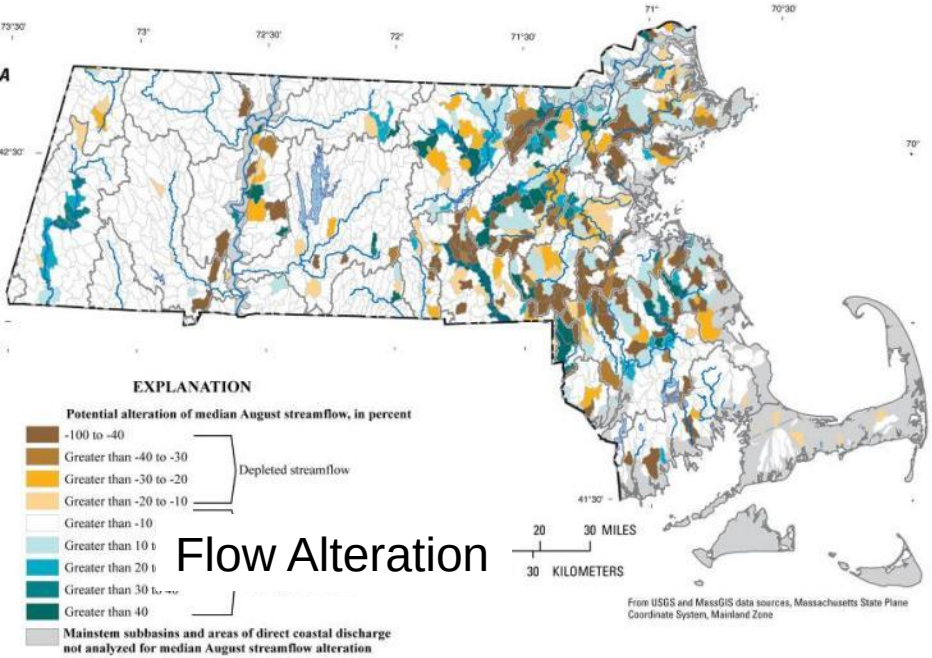
1.
Archfield, and others, 2010, **The Massachusetts Sustainable-Yield Estimator – a decision-support tool to assess water availability at ungaged stream locations in Massachusetts**: USGS Scientific Investigations Report 2009-5227, 41 p.

2.
Weiskel and others, 2010, **Indicators of streamflow alteration, habitat fragmentation, impervious cover, and water quality for Massachusetts stream basins:** USGS Scientific Investigations Report 2009–5272, 79 p.

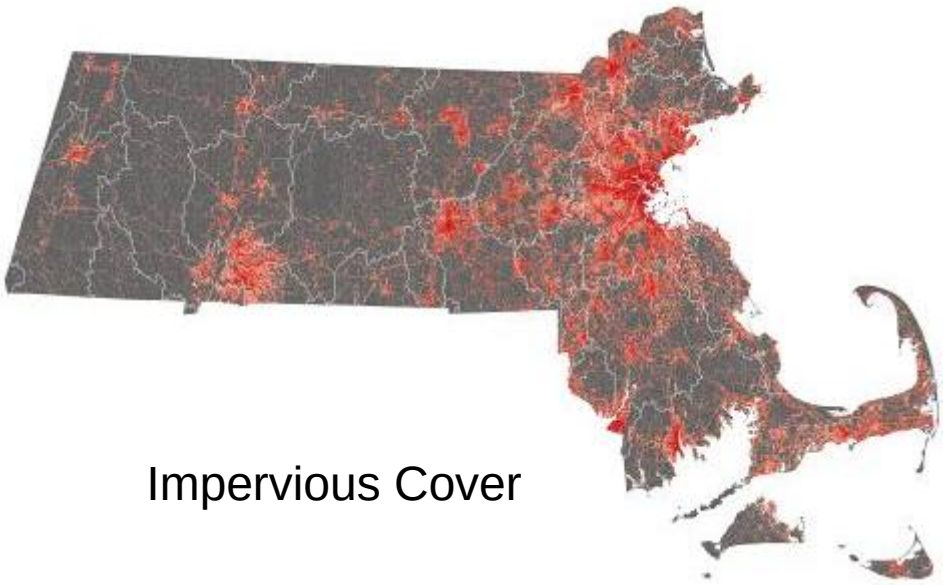
3.
Armstrong and others, 2010, **Preliminary Assessment of Factors Influencing Riverine Fish Communities in Massachusetts**, USGS Open-File Report 2010–1139.

Streamflow and Habitat

Factors Influencing Riverine Fish Communities in Massachusetts



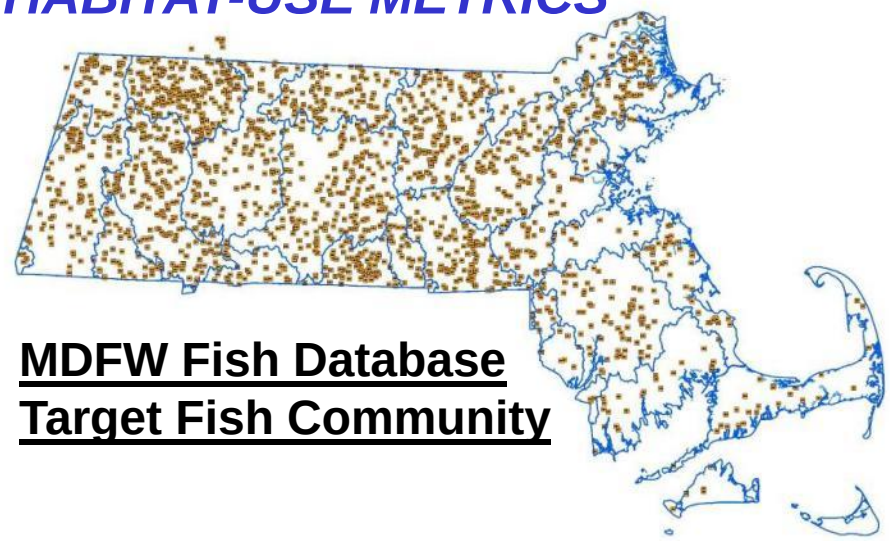
Flow Alteration



Impervious Cover

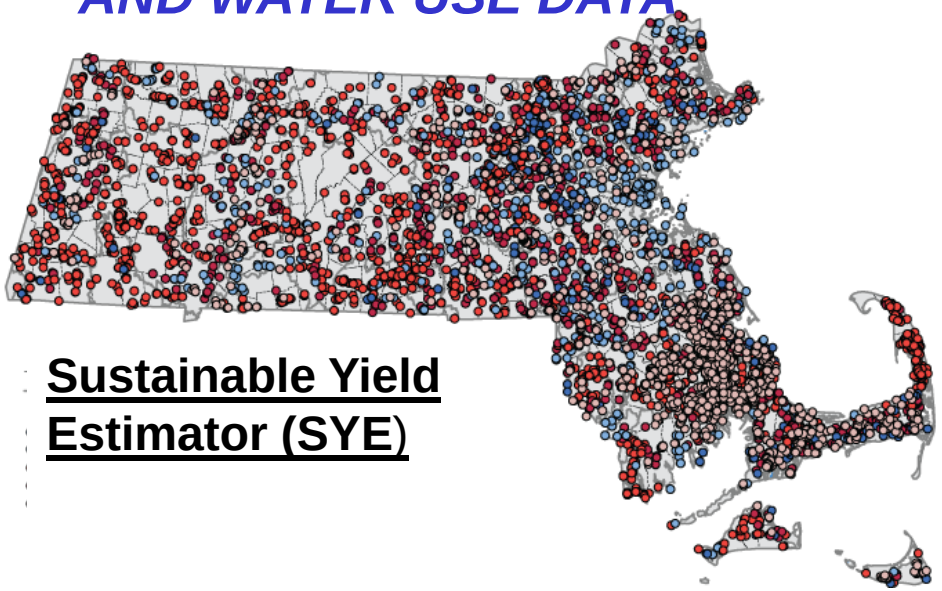
Opportunity: new data and new tools made this project possible

FISH DATA AND HABITAT-USE METRICS



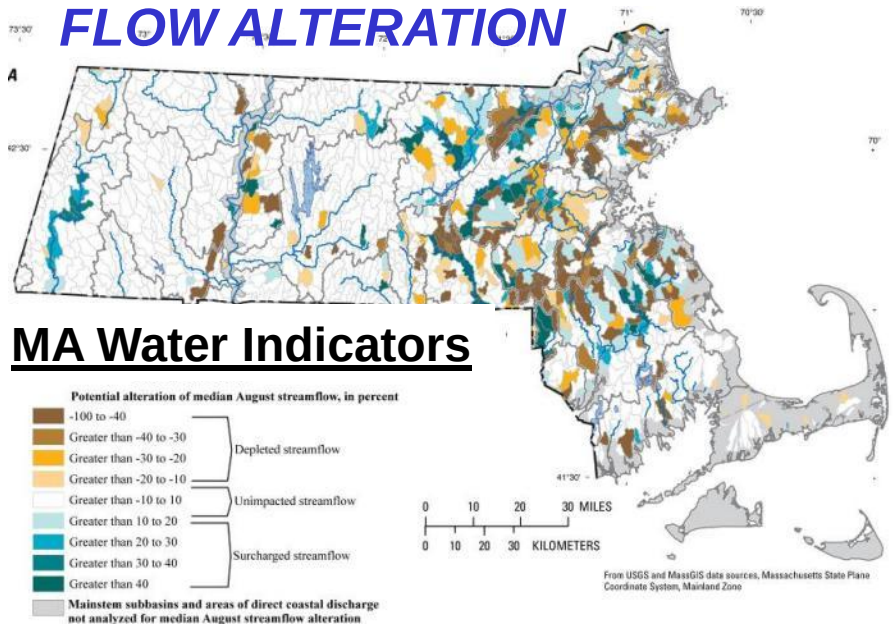
MDFW Fish Database
Target Fish Community

STREAMFLOW AND WATER USE DATA



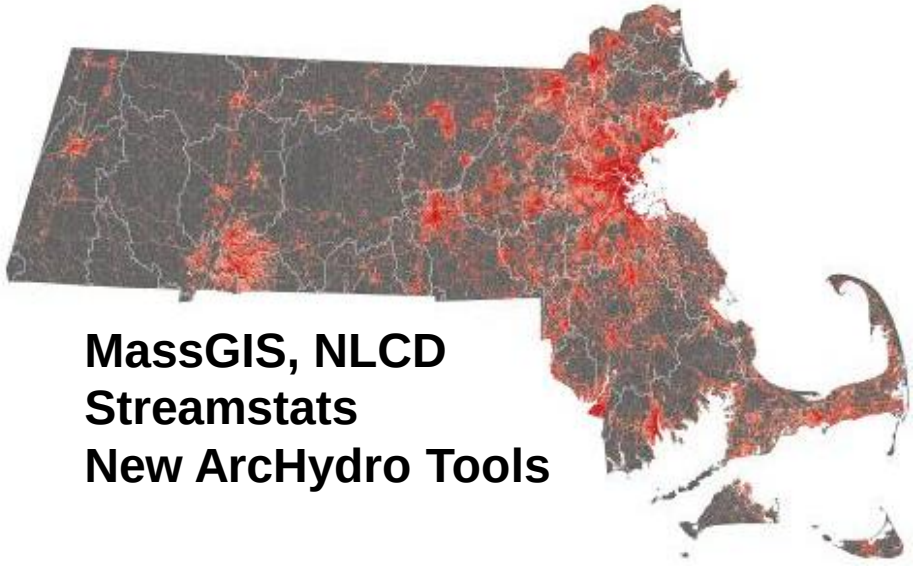
Sustainable Yield Estimator (SYE)

FLOW ALTERATION



MA Water Indicators

GIS COVERAGES AND TOOLS



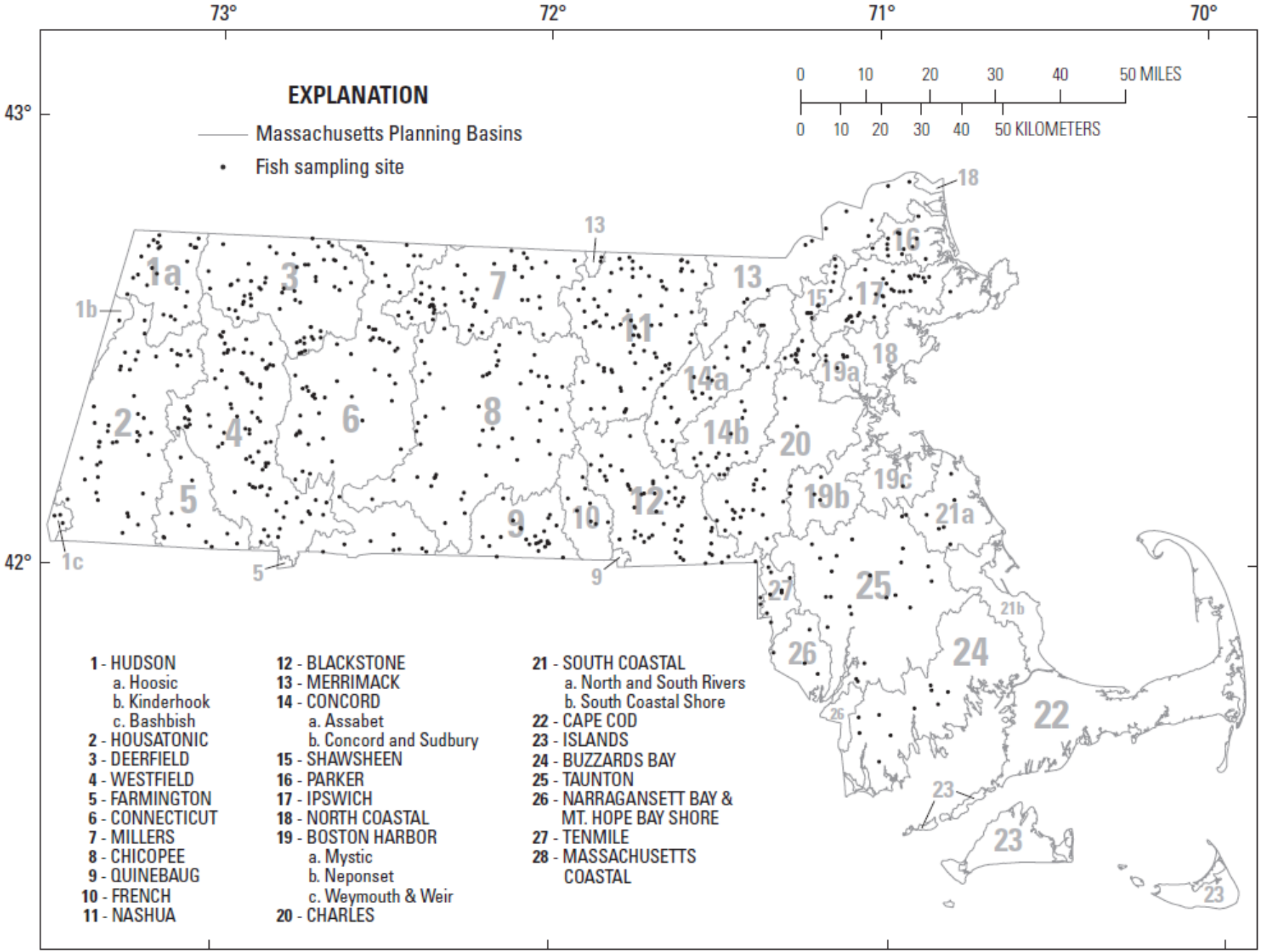
MassGIS, NLCD
Streamstats
New ArcHydro Tools

Project objective:

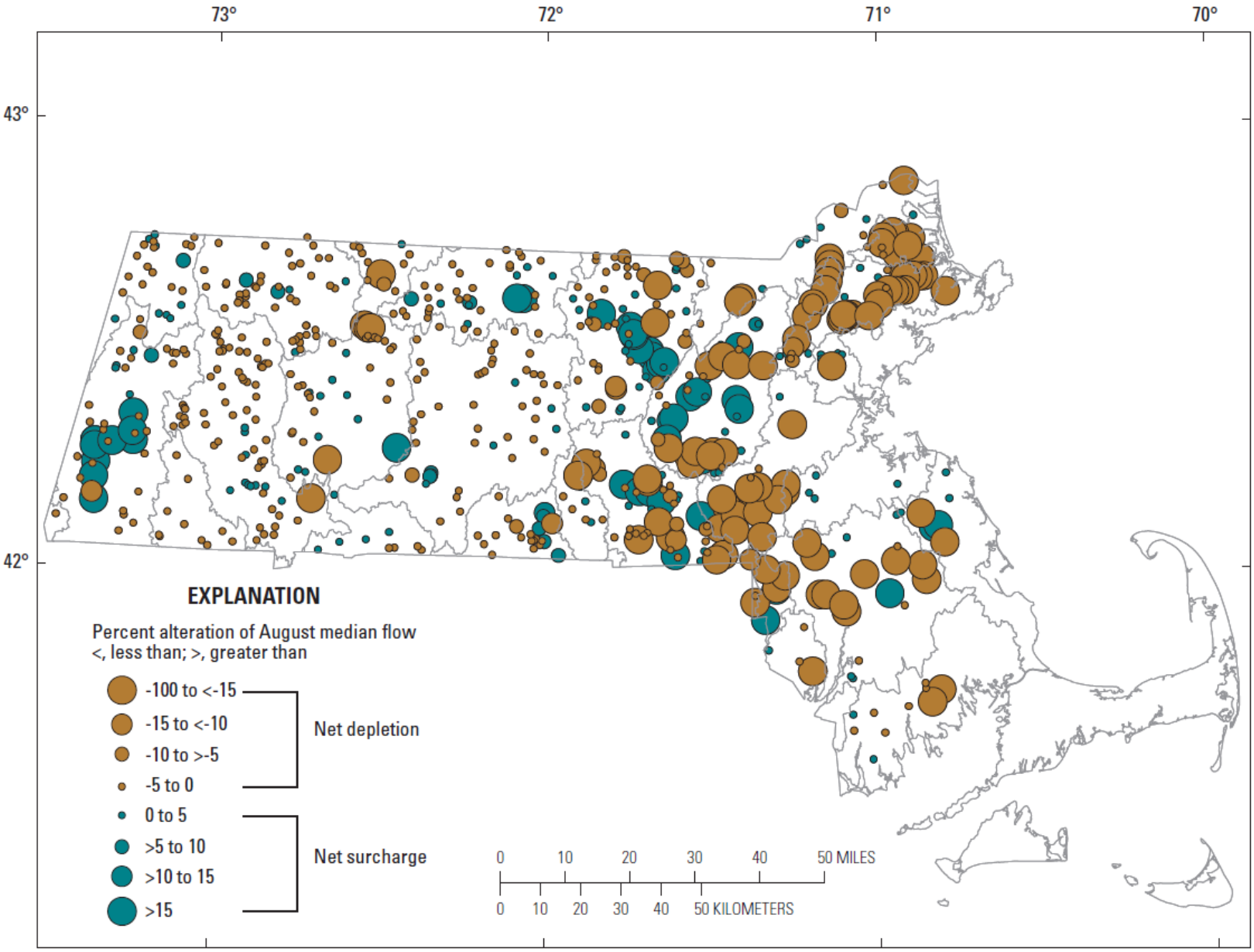
Assess the response of stream fish communities in Massachusetts to:

- **-- natural basin characteristics**
- **-- flow alteration**
- **-- other forms of anthropogenic stress (such as impervious cover)**

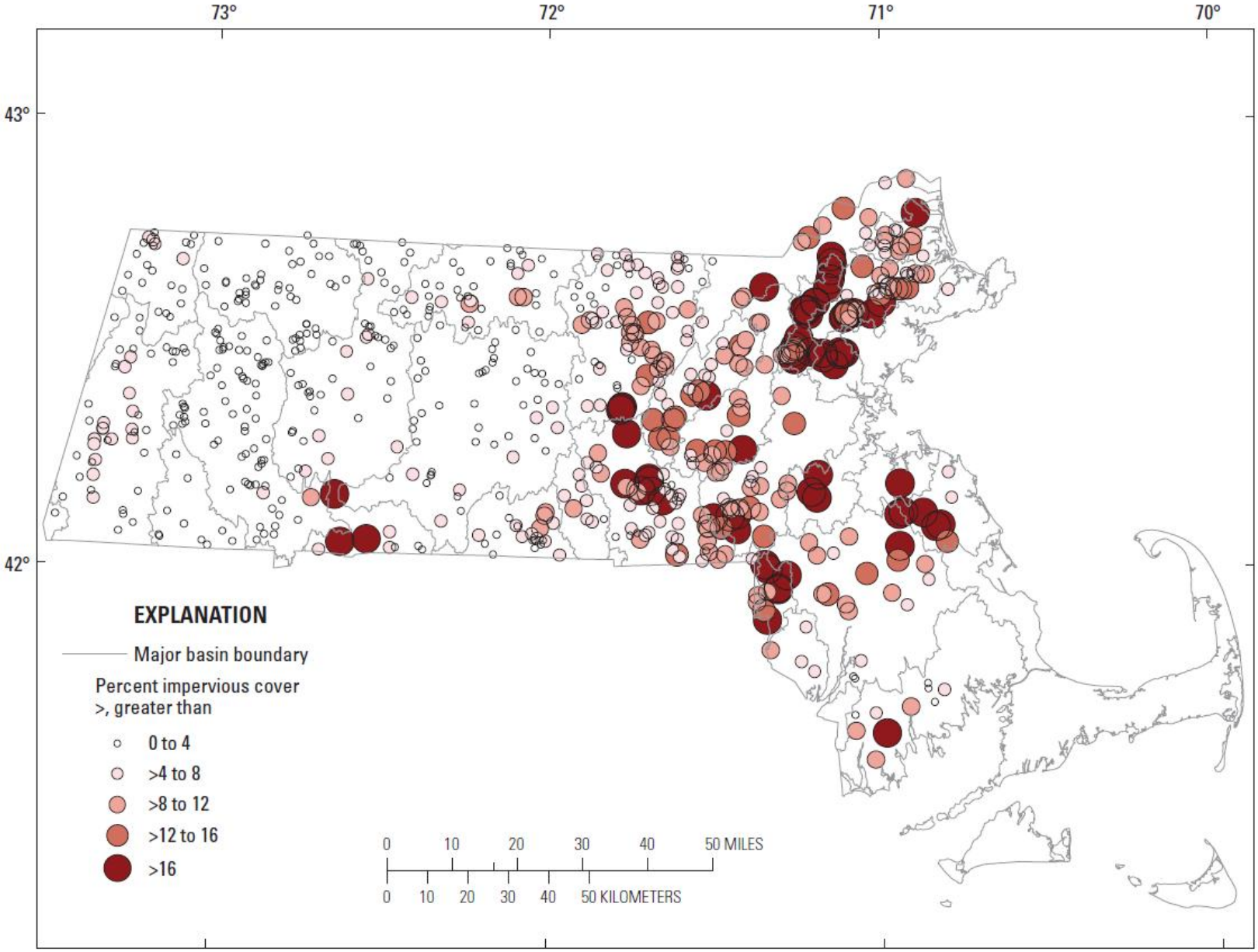
The study used 756 fish sampling sites, collected 1998-2008



Flow alteration for the 756 fish-sampling sites



Impervious cover for the 756 fish-sampling sites



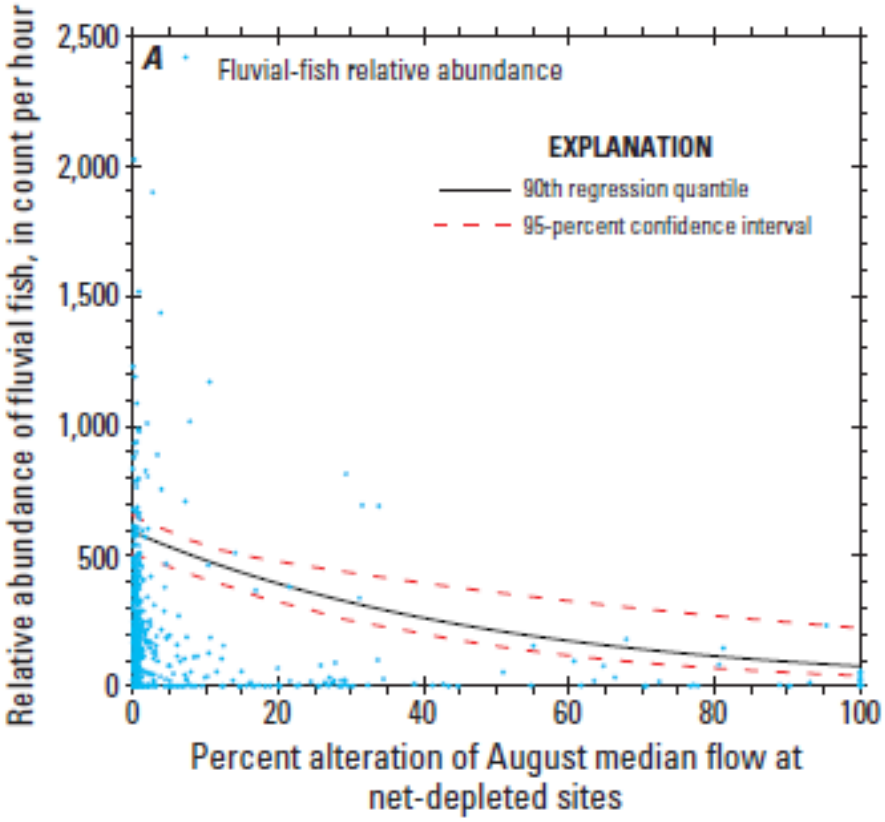
Two analytical tools were applied

Quantile Regression

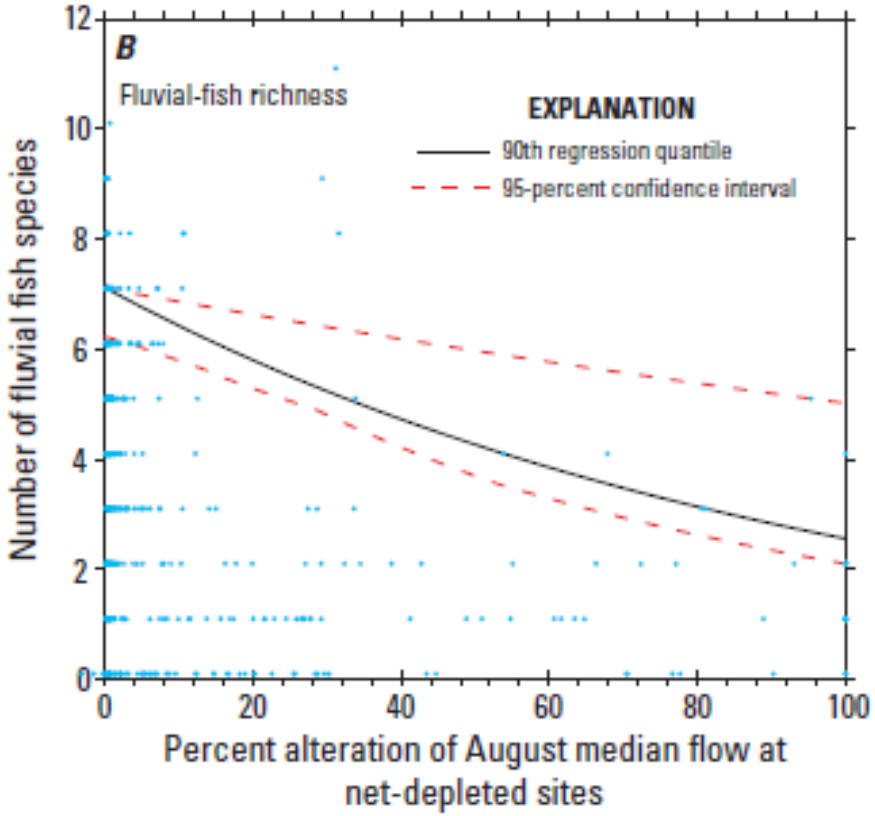
Generalized linear modeling

Quantile regression – Flow Alteration

Fluvial fish abundance vs. flow alteration

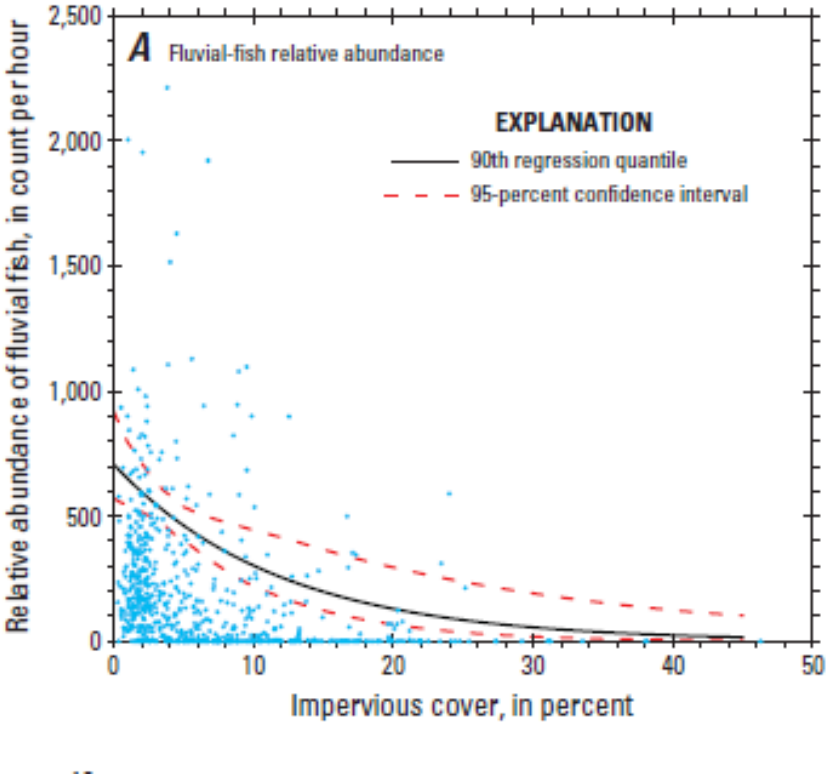


Fluvial fish richness vs. flow alteration

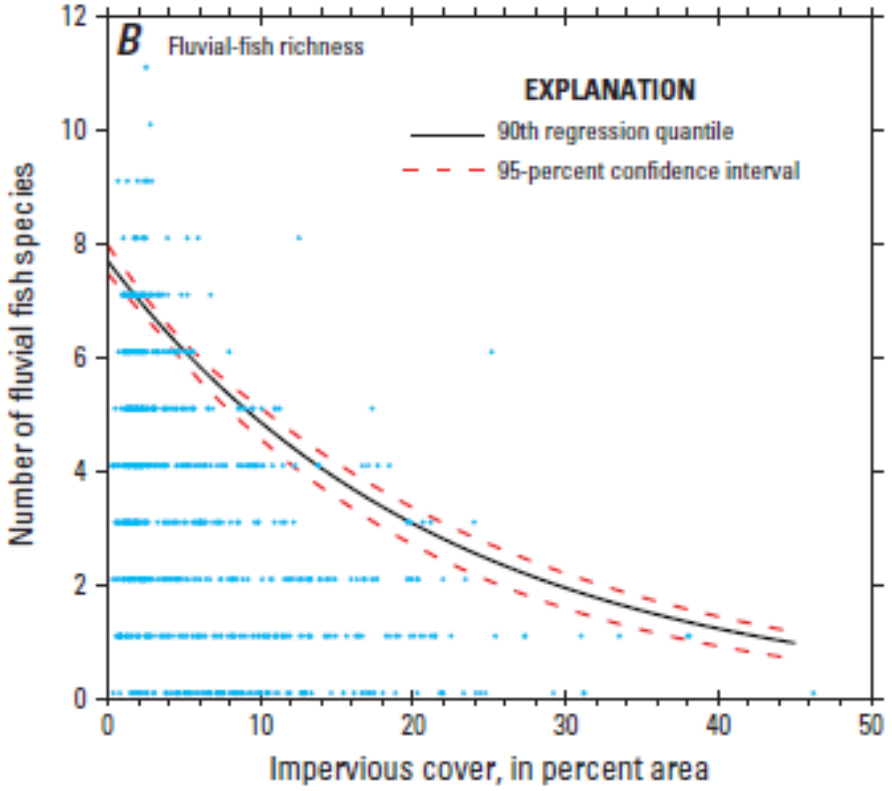


Quantile regression – impervious cover

Fluvial fish abundance vs. impervious cover



Fluvial fish richness vs. impervious cover



Three multivariate, Generalized Linear Model equations were developed to relate natural and anthropogenic variables to:

1. Fluvial fish species richness
2. Fluvial fish relative abundance
3. Brook trout relative abundance

Fluvial fish relative abundance was found to depend upon:

- **Drainage area**
- **Percent wetland**
- **Channel slope**
- **Longitude**

- **Percent alteration of August flow**
- **Impervious cover**

Major Findings, GLM analysis

• A unit increase in **August flow alteration** for net depleted or net surcharged streams is associated with a 0.4% decrease in fluvial fish abundance—which translates to 1% (on average) reduction in the range of fluvial fish abundance observed between 0 and 100% flow alteration.

• A unit increase in percent **impervious cover** is associated with a 5.5% decrease in fluvial density— by 10-15% IC, most fluvial fish are gone from stream.

USGS Products

- Archfield, S.A., Vogel, R.M., Steeves, P.A., Brandt, S.L., Weiskel, P.K., and Garabedian, S.P., 2010, The Massachusetts Sustainable-Yield Estimator: A decision-support tool to assess water availability at ungaged stream locations in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2009–5227, 41 p. plus CD-ROM. **http://pubs.usgs.gov/sir/2009/5227/**

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- Armstrong, D.S., Richards, T.A., and Brandt, S.L., 2010, Preliminary assessment of factors influencing riverine fish communities in Massachusetts: U.S. Geological Survey Open-File Report 2010–1139, 43 p. **http://pubs.usgs.gov/of/2010/1139/**

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Water Resources Commission
Commonwealth of Massachusetts

Presentation Title: Streamflow Criteria

Presented By: Todd Richards, Fisheries Biologist
Department of Fish and Game

Date of Presentation: 18 November 2010

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Stream Categorization: Describing the Current Condition

Categorization

- Statewide Screening Tool
- Describe the Current Condition
- Using Best Available Science
- Living Document
- Useful Tool for Discussion of:
  - Goal Setting
  - Streamflow Criteria
  - Safe Yield

Fish Communities

- The Fish Tell the Story
  - Long-lived
  - Reflect stresses over time
  - Easily recognized and identified
  - Well-studied
  - Good indicators of the condition of the aquatic environment

Rivers Should Have River Fish Communities

What is a River Fish?

Brook Trout

Fallfish

Creek Chubsucker

Tesselated Darter

Common Shiner

Preliminary Assessment of Factors Influencing Riverine Fish Communities in Massachusetts

by

David Armstrong
Sara Brandt

U.S. Geological Survey
Massachusetts-Rhode Island Water Science Center

and

Todd Richards
Massachusetts DFW

USGS
science for a changing world

In cooperation with the
Massachusetts Department of Conservation and Recreation,
The Massachuetts Department of Environmental Protection, and the
Massachusetts Department of Fish and Game

Preliminary assessment of factors influencing riverine fish communities in Massachusetts

By David S. Armstrong, Sara L. Brandt, Todd A. Richards, and Matt Baker?

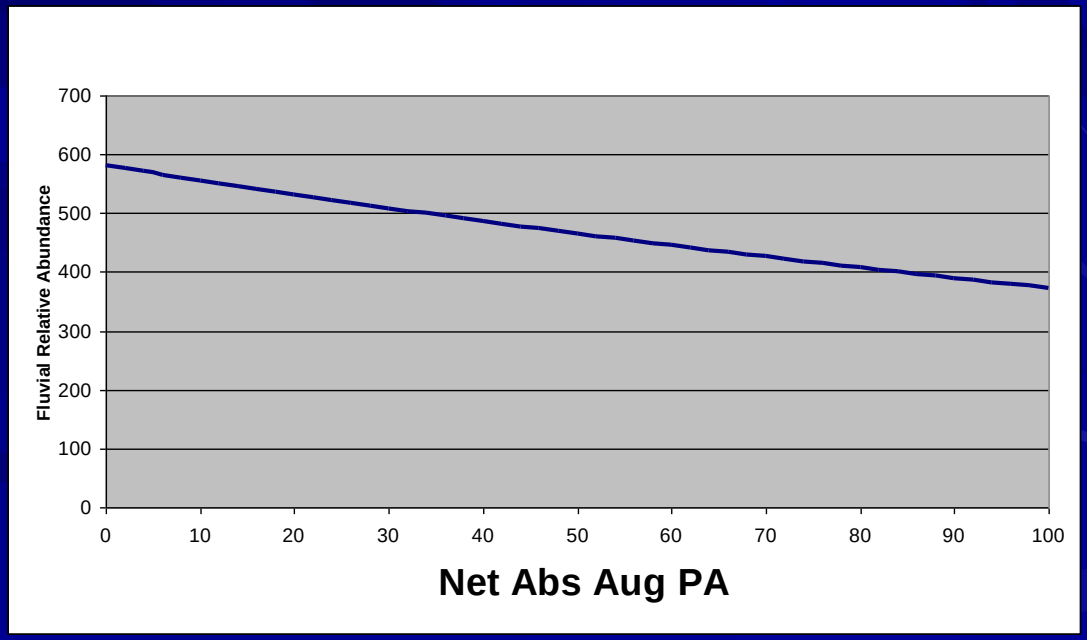
Open File Report 201X-XXX

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

1

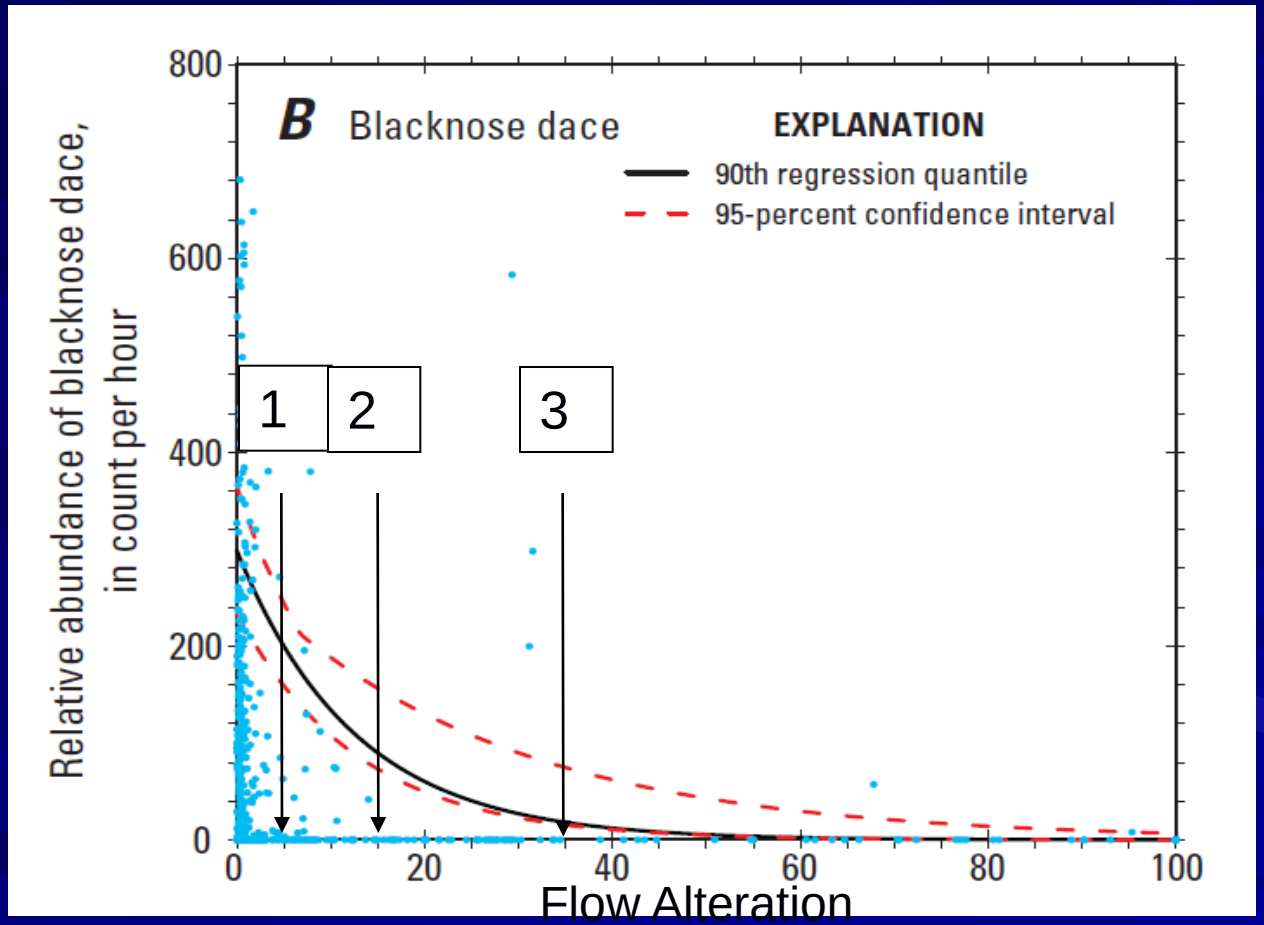
Foundation: USGS Study
Fluvial Fish Relative Abundance Model

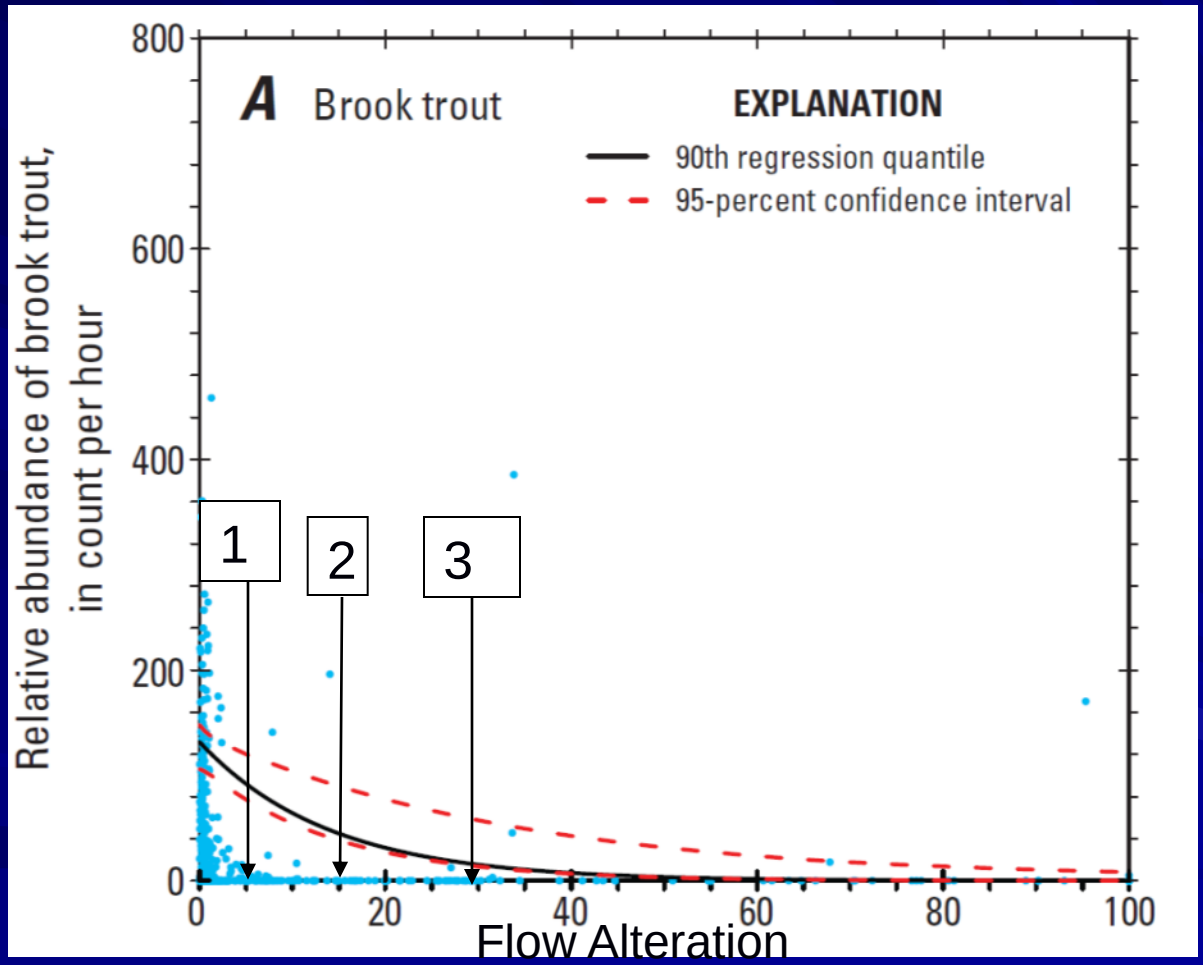
- Benefits
  - Highly significant variables
  - Best Model that Included
    - Natural Basin Characteristics
    - Flow Alteration
    - Impervious Cover



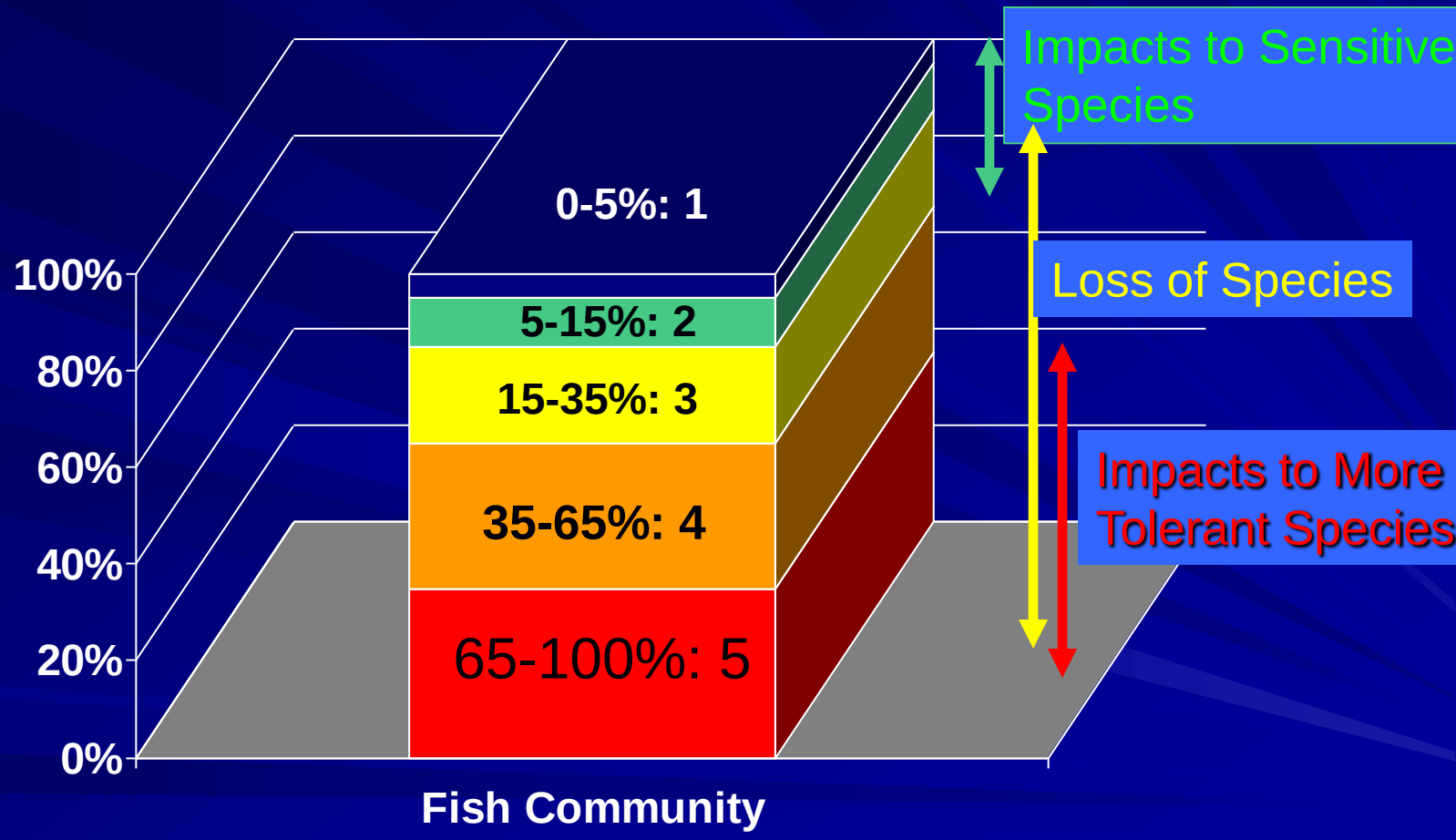
Categories

- Categories are Narrow at low end of alteration – High quality resources have sensitive populations that respond more extensively to alteration
  - Quantile Regression
- Categories are Broad at high end of alteration – Communities of more tolerant individuals remain, providing less change per unit alteration
  - GLM equation
  - Biological Conditions Gradient

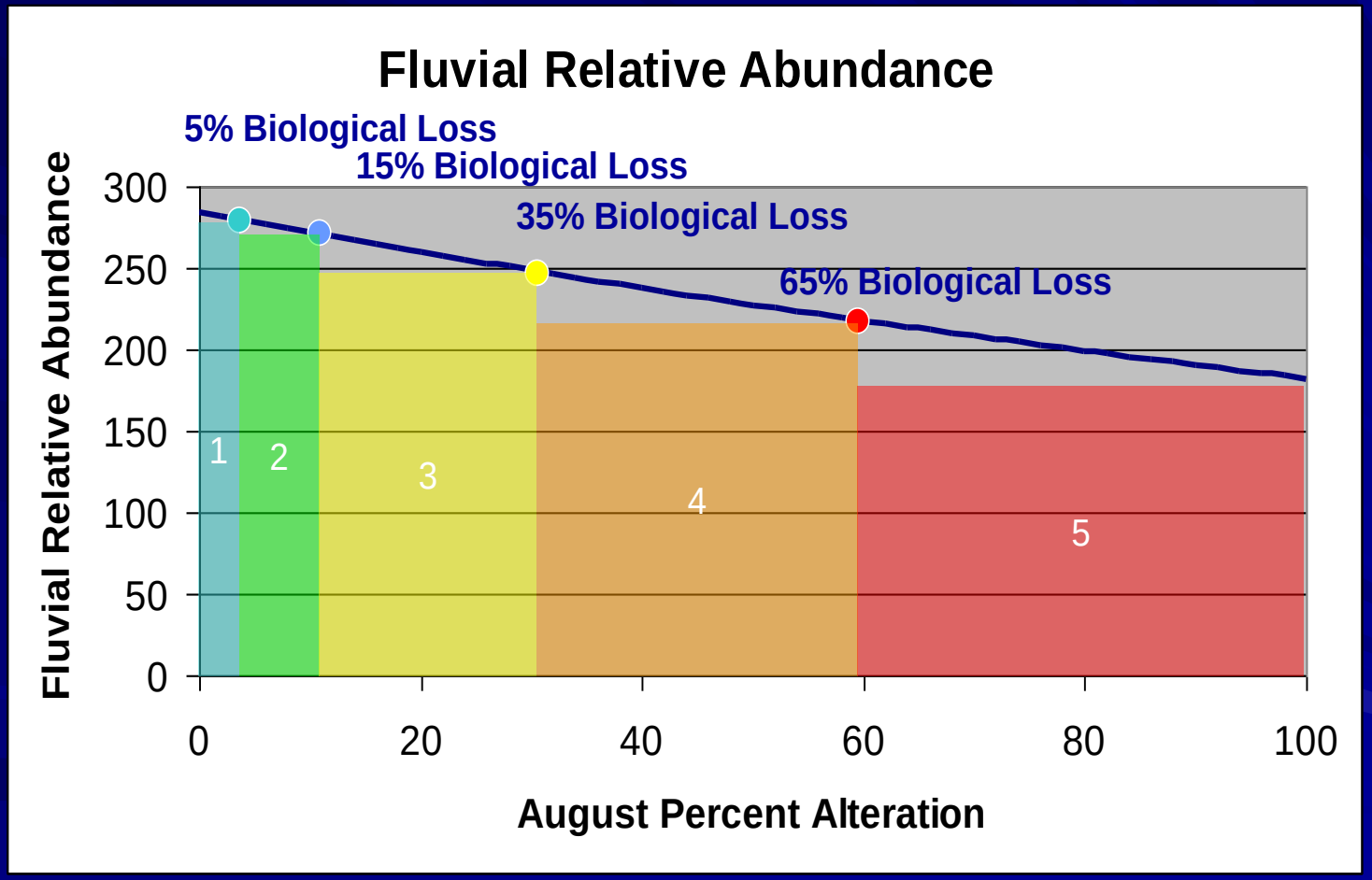

B Blacknose dace
EXPLANATION
90th regression quantile
95-percent confidence interval
1
2
3
Relative abundance of blacknose dace, in count per hour
800
600
400
200
0
0
20
40
60
80
100
Flow Alteration


A Brook trout
EXPLANATION
90th regression quantile
95-percent confidence interval
Relative abundance of brook trout, in count per hour
800
600
400
200
0
0
20
40
60
80
100
Flow Alteration
1
2
3

Fish Community Response

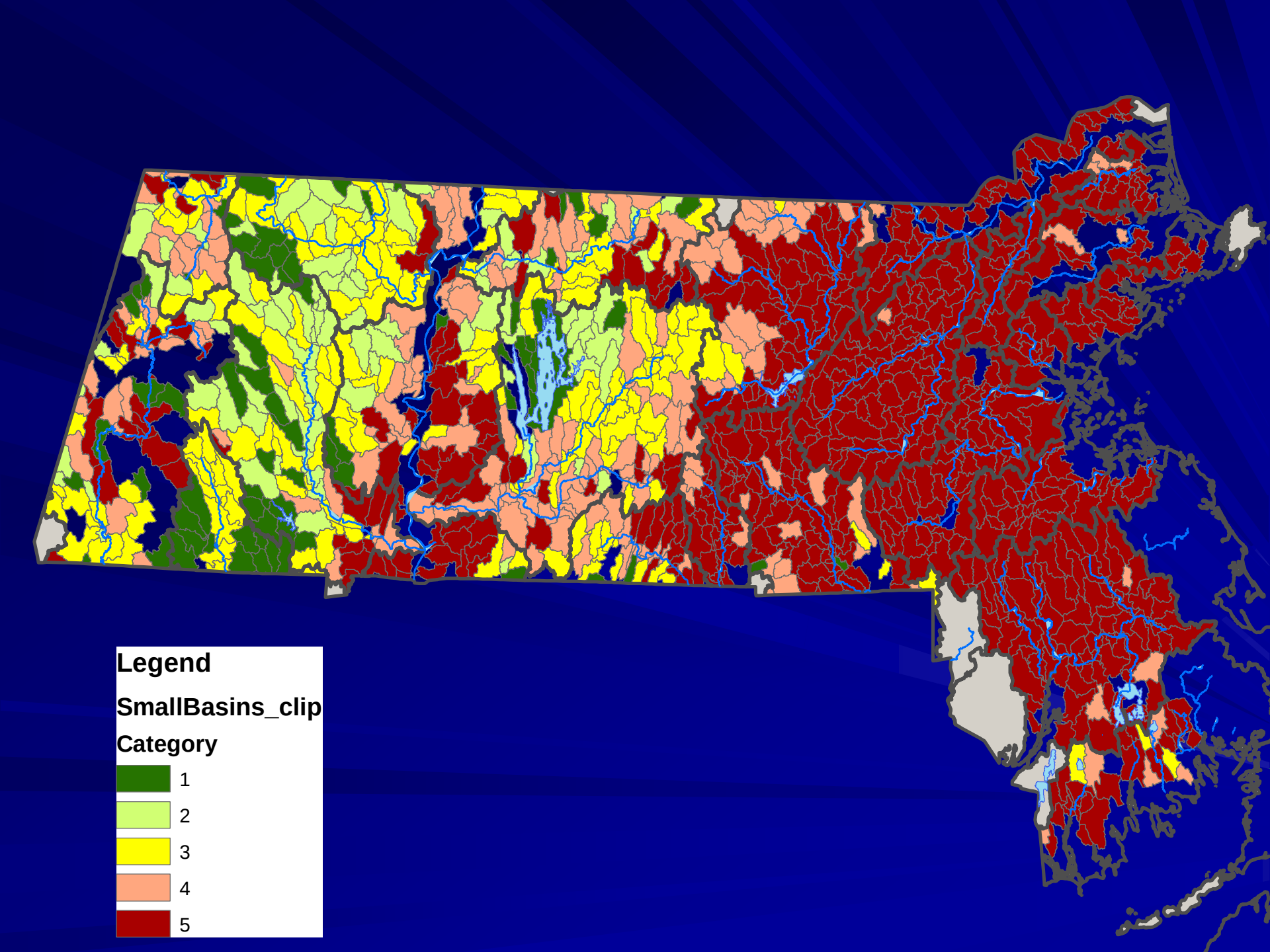


Range of Fluvial Fish Relative Abundance



Basin-Specific Calculation

- Enter individual basin variables
- MWI 1429 Sub-basins
- Run Regression Equation


Legend
SmallBasins_clip
Category
1
2
3
4
5

Categorization

- Statewide Screening Tool
- Describe the Current Condition
- Using Best Available Science
- Living Document
- Useful Tool for Discussion of:
  - Goal Setting
  - Streamflow Criteria
  - Safe Yield

Water Resources Commission
Commonwealth of Massachusetts

Presentation Title:	An update from the Sustainable Water Management Advisory Committee. A review of the current discussions regarding Safe Yield and Streamflow Criteria
Presented By:	Dr. David Cash, Assistant Secretary for Policy Executive Office of Energy and Environmental Affairs
Date of Presentation:	18 November 2010

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SAFE YIELD AND STREAMFLOW CRITERIA UPDATE

EOEEA SUSTAINABLE WATER MANAGEMENT INITIATIVE

For the Massachusetts Water Resources Commission
November 18, 2010

The SWMI "Package"

- Safe Yield
  - A Drought volume that considers storage and an environmental protection factor- may or may not be allocatable depending on Sustainable Allocation Process
- Sustainable Allocation and Management
  - Biological Categories (completed)
  - Water Supply Categories (in progress)
  - Streamflow Criteria (in progress)
  - Impervious Guidelines (beginning)
  - Goal Setting (beginning)
  - Mitigation/Restoration Plans (next step)
  - Allocation Methodology (next step)
  - Address other stressors- dams, wastewater (next step)

Components of Safe Yield

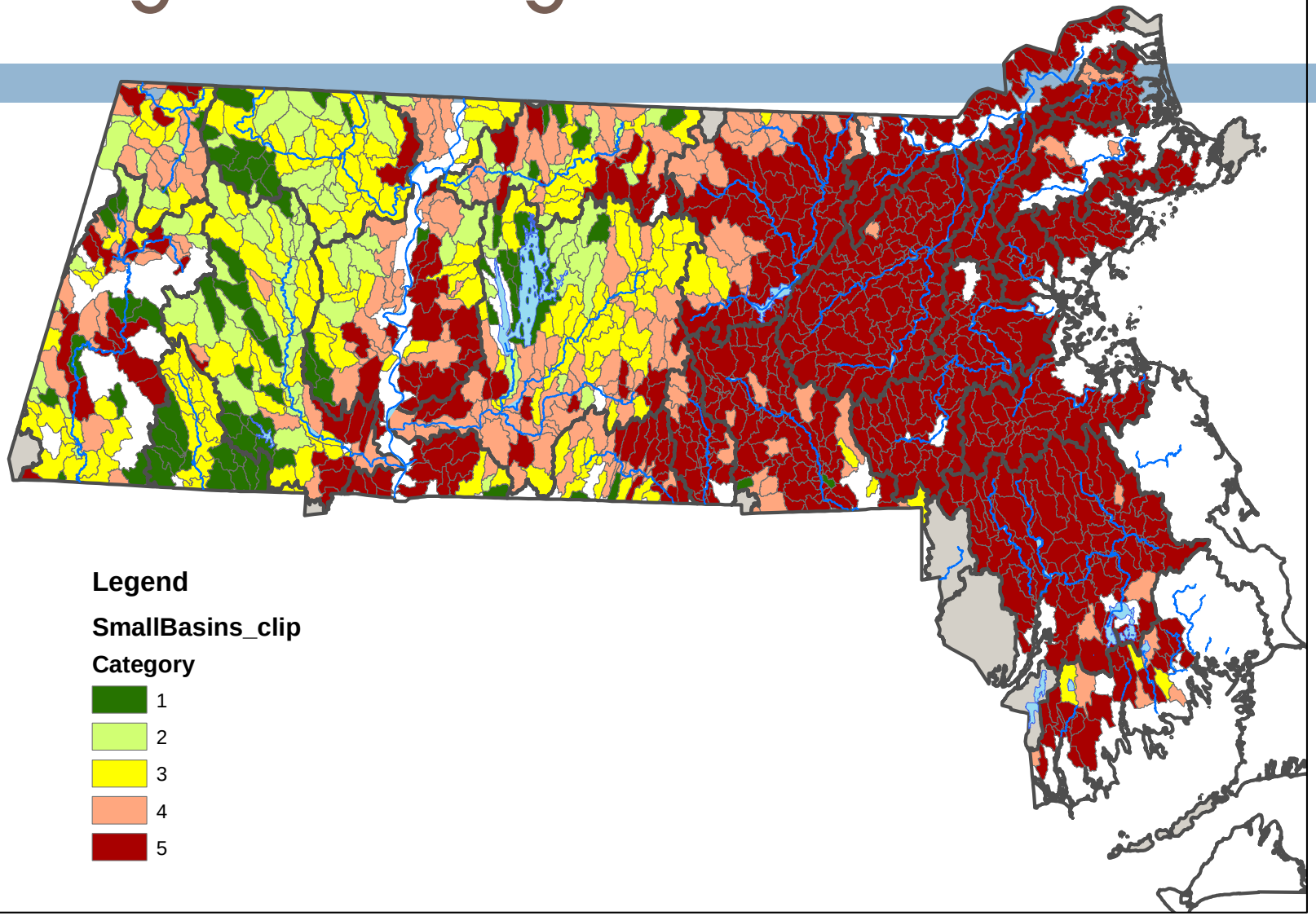
- Basin Yield, Drought/probable driest period (BY)
- Drought Environmental Protection Factor (EPF)
- Storage Volume (above 1 yr of inflow/use) (S)

- Areas of ongoing discussion:
  - What scale? (27 major basins, ~120 HUC-12s, 1,400 small subbasins)
  - What time step? (annual volume, monthly volume, hybrid)
  - Should return volumes be counted?

Components of Sustainable Allocation

- Sustainable Allocation
  - Biological Categories describe existing aquatic condition (Response of fluvial fish metric to August flow alteration, impervious cover and natural basin features)
  - Water Supply Categories describe existing/future water use and needs
  - Streamflow Criteria (SFC) set seasonal, subbasin flow limits that can provide additional protection
  - Goal Setting determine where and how SFC are applied, and develop Mitigation/Restoration Plans to meet goals
- Develop Allocation Methodology

Biological Categories

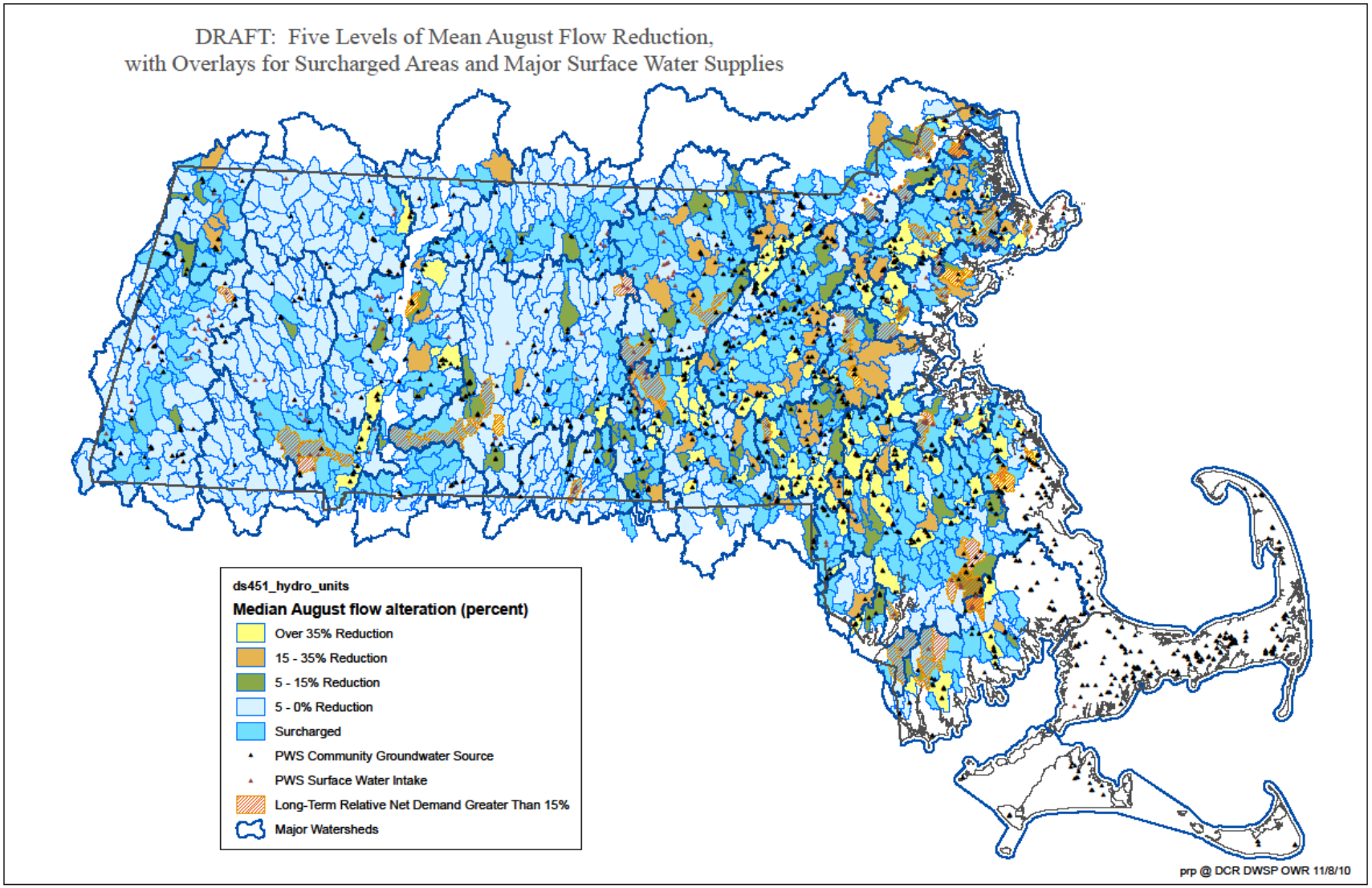


Flow Alteration Levels*

Flow Alteration Level	August % Alteration	Flow basins % and #	Flow surcharged basins % and #	Total % of subbasins in flow level
1	< 5%	39% (496)	18% (222)	57%
2	5 – 15%	8% (99)	9% (111)	17%
3	15 – 35%	6% (78)	7% (84)	13%
4	35 – 65%	4% (45)	2% (30)	6%
5	> 65%	5% (67)	2% (28)	7%

* Established by running the fish model assuming 1% impervious

Flow Alteration Levels



FOR DISCUSSION PURPOSES ONLY - NOT TO BE CITED

DRAFT Impervious Levels*

Impervious Cover Level	% Impervious	% and # of basins
1	< 1%	
2	1 – 3%	
3	3 – 6%	
4	6 – 9%	
5	> 9%	

* To be established by running the fish model assuming 0% August Alteration

Impervious Surface Levels

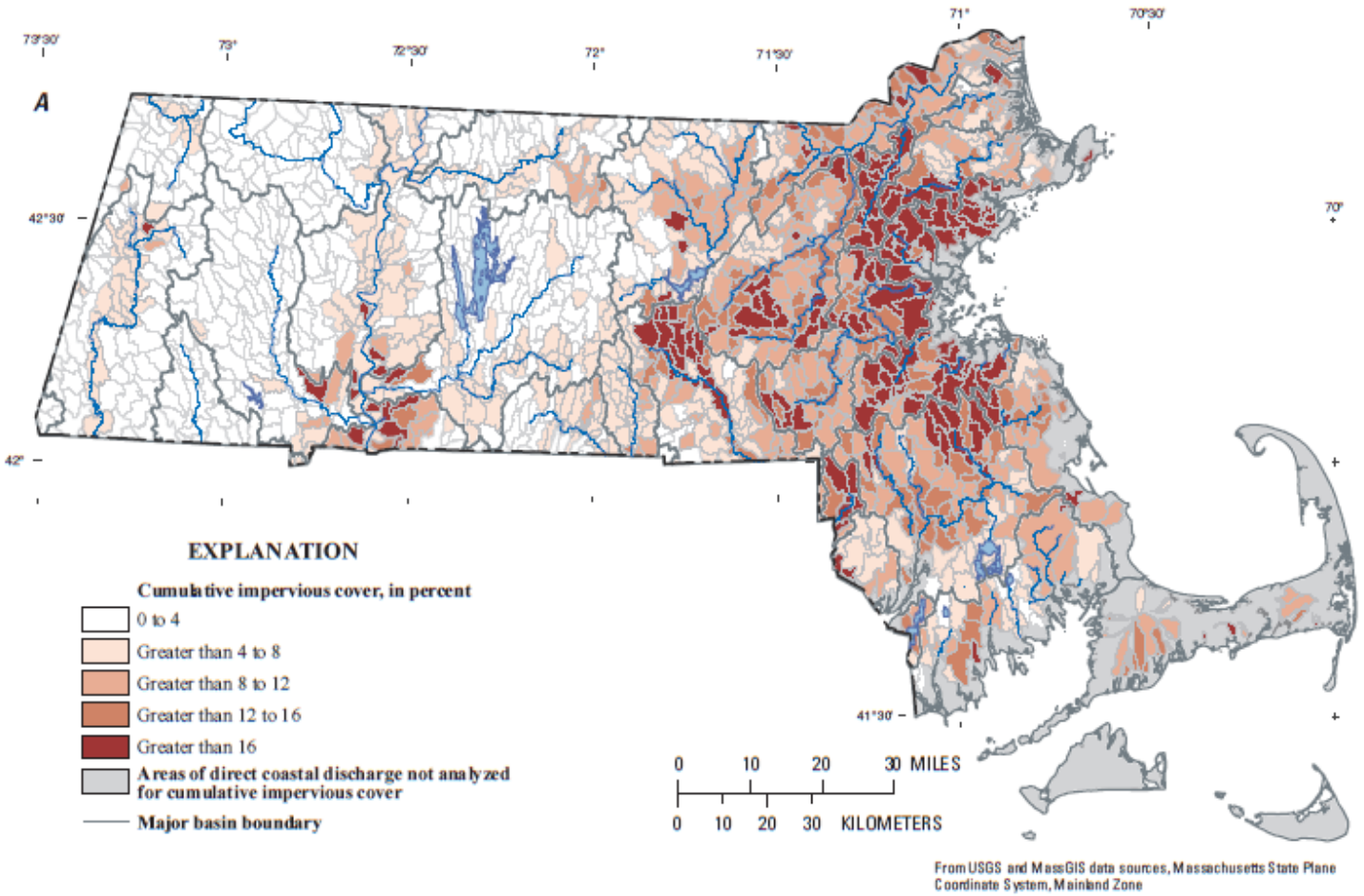


Figure 24. *(A)* Cumulative percent impervious cover in Massachusetts subbasins. *(B)* Cumulative percent impervious cover in Massachusetts 12-digit Hydrologic Unit Code (HUC-12) basins.

Goal Class Concept

- Goal Class is independent from, but informed by existing condition
- Goal Classes Example:
  - Goal Class 1: High Quality Aquatic Habitat
  - Goal Class 2: Default
  - Goal Class 3: Major Water Supply Areas
- Set Statewide Goal Classes and establish a process for basin-specific goal classes where needed
- Set Criteria to support each Goal Class

Goals we've heard

- No backsliding out of category
- Improve to at least a category 3
- Everyone goes up one category
- Identify and protect water supply areas
- Identify and protect cold water fisheries and other high quality aquatic habitat
- "enough water for people and fish"

Example Goal Class Criteria

GOAL CLASSES	August Maximum % alteration	October Maximum % alteration	January Maximum % alteration	April Maximum % alteration
Goal Class 1	5%	multiplier TBD	multiplier TBD	multiplier TBD
Goal Class 2	15%	”	”	”
Goal Class 3	35%	”	”	”

Data that could inform goal class decision

- Biological Category
- Flow Alteration Level
- Impervious Level
- Designated Coldwater Fishery
- Mapped future water supply
- Economic Development Areas
- Other?

Goal Class Example 1- no backsliding of flow level

	Flow Level (August % Alteration)				
Biological Category	1 0 to 5%	2 5-15%	3 15-35%	4 35-65%	5 >65%
1	61	-	-	-	-
2	86	-	-	-	-
3	145	6	1	-	-
4	120	20	9	1	-
5	84	73	68	44	67

Each cell shows the number of small subbasins (reduced only, 785 total out of 1,429)

Goal Class Example 2- no backsliding of biological category

	Flow Level (August % Alteration)				
Biological Category	1 0 to 5%	2 5-15%	3 15-35%	4 35-65%	5 >65%
1	61	-	-	-	-
2	86	-	-	-	-
3	145	6	1	-	-
4	120	20	9	1	-
5	84	73	68	44	67

Each cell shows the number of small subbasins
(reduced only, 785 total out of 1,429)

Goal Class Example 3- no backsliding and manage towards a flow level 3

	Flow Level (August % Alteration)				
Biological Category	1 0 to 5%	2 5-15%	3 15-35%	4 35-65%	5 >65%
1	61	-	-	-	-
2	86	-	-	-	-
3	145	6	1	-	-
4	120	20	9	1	-
5	84	73	68	44	67

Each cell shows the number of small subbasins (reduced only, 785 total out of 1,429)

Goal Class Example 4- no backsliding and manage towards a biological category 3

	Flow Level (August % Alteration)				
Biological Category	1 0 to 5%	2 5-15%	3 15-35%	4 35-65%	5 >65%
1	61	-	-	-	-
2	86	-	-	-	-
3	145	6	1	-	-
4	120	20	9	1	-
5	84	73	68	44	67

Each cell shows the number of small subbasins (reduced only, 785 total out of 1,429)

Next Steps

- Goal Setting Process
  - Establish Statewide Goal Classes
  - Identify criteria for statewide goal classes
  - Outline basin-specific goals process
  - Timeline and mitigation/restoration plan to meet goals
- Establish Allocation Methodology
- Implementation
  - Incentives (Go with the Flow Program), permits, regulations, etc.

Additional detail slides on Safe Yield

Environmental Protection Factor: Example

- Basin Yield = Monthly Q90s
- Apply fish and flow ratio to get drought environmental reserve and allocatable volumes
- Allocatable portion = 25% MQ50/M Q90 (cap at 65%- max monthly allocation 65% of DBY)