Partnering to Establish a Sustainable Biological Monitoring Program

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Charles River Watershed Association
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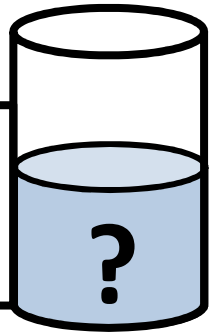
Charles River Watershed Association

Statement of Problem

Water quality is essential,
but resources for monitoring are limited.



Project Goals

1. Add macroinvertebrate biomonitoring to existing volunteer monitoring program

2. Evaluate biomonitoring methods

1. Assess water quality in the Charles River Watershed

2. Evaluate efficacy of citizen science for biomonitoring

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Project Team

Charles River Watershed Association (CRWA)

- Strong volunteer network
- Strong ties to community
- Outreach capabilities
- Extensive knowledge of watershed
- Extensive knowledge of Charles water quality
- Extensive knowledge of and connections to State and other monitoring programs
- Eligible for grant funding

UMass Boston Freshwater Ecology Lab (FEL)

- Technical expertise in benthic macroinvertebrate collection and identification
- Technical expertise in various habitat assessment protocols

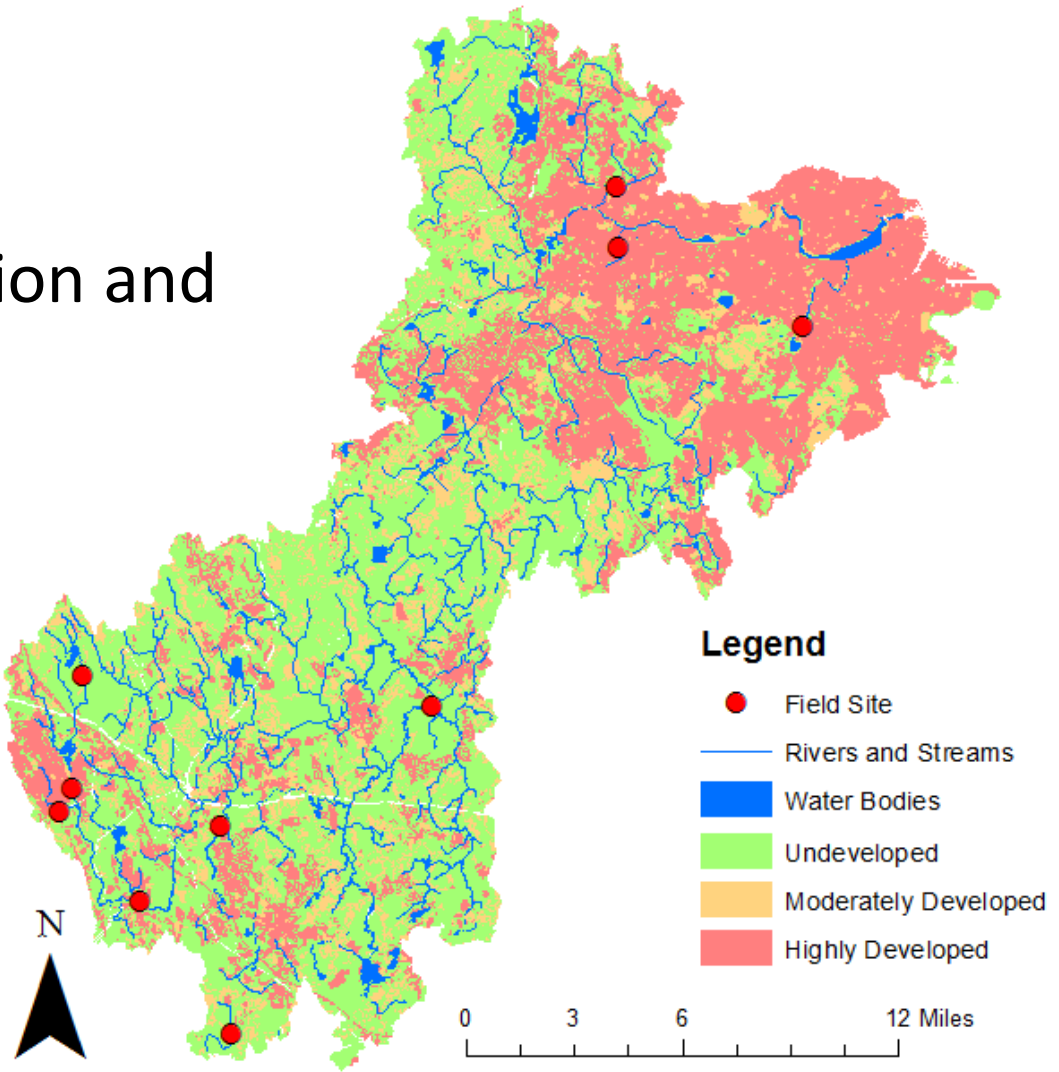
Christina Ciarfella, UMass Boston student

- Biology background
- In need of a thesis project
- Interested in project with real-world application
- In need of project funding

Background

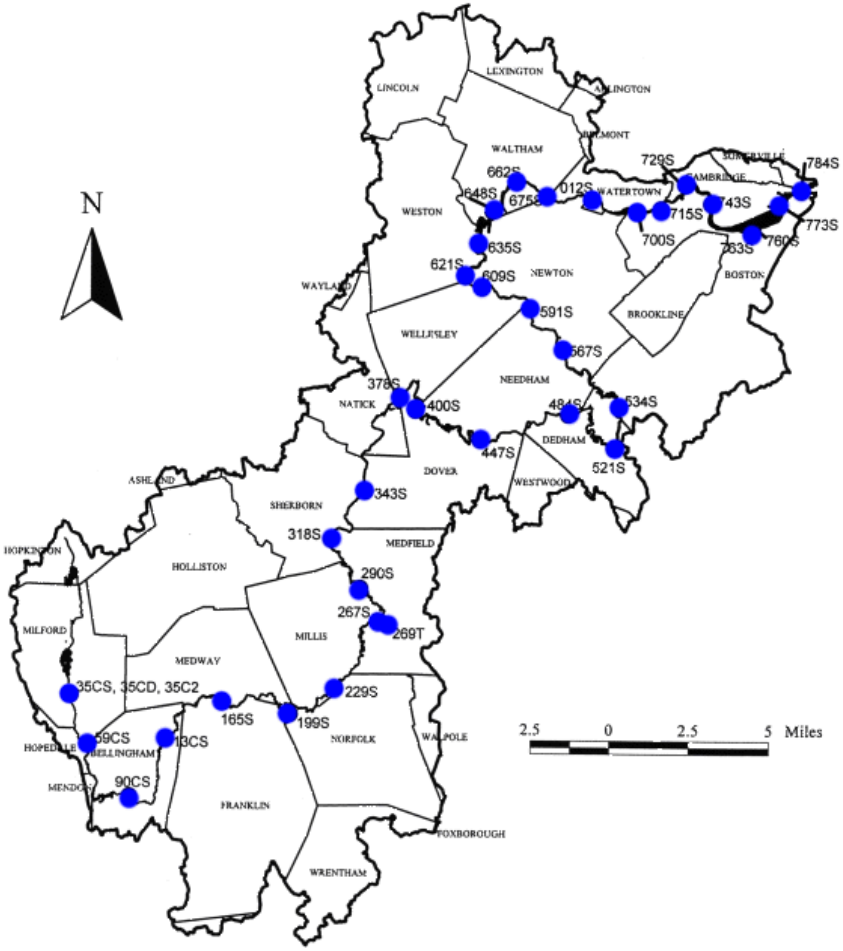
Charles River Watershed > Biomonitoring

- Complex hydrology
- Long history of habitation and use
- Varied land use but heavily developed
- Active, long-running volunteer monitoring program



Charles River Watershed Association's Volunteer Water Quality Monitoring Program

- Established in 1995
- 37 stations
- 70+ volunteers
- Monthly *E. coli* samples and temperature and depth measurements
- Quarterly nutrient, chlorophyll *a* and TSS at 12 sites
- Sample analysis is done at an external laboratory



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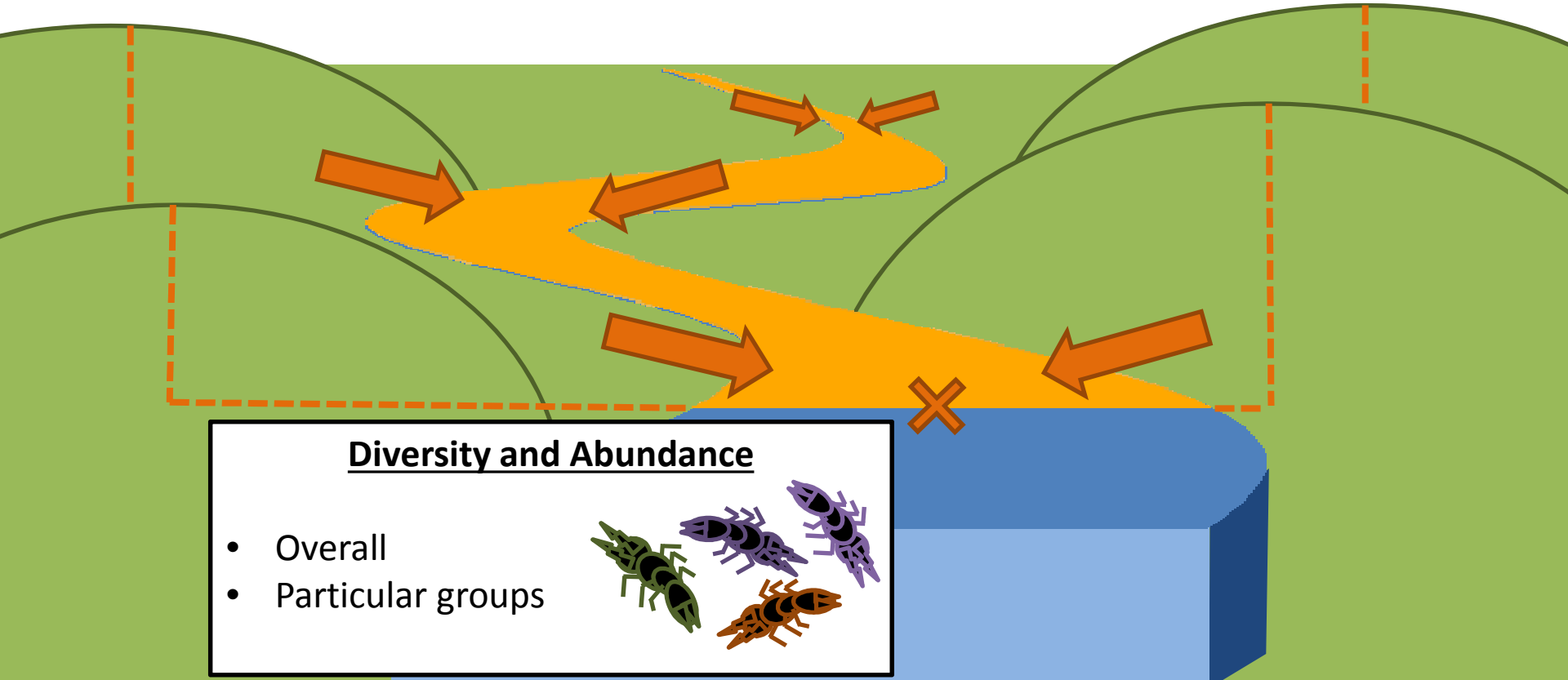
Background

Charles River Watershed > **Biomonitoring**

River Continuum Concept: *Conditions at a point in a waterway are the integration of local and upstream conditions*

Bioassessment: *The biological conditions reflect the physical and chemical conditions*



Background

Charles River Watershed > **Biomonitoring**

Why use these proxies for water quality?

- Low resource requirements
  - Increase monitoring frequency and area
  - Developing economies
- General indicators
  - Compliment specific physical-chemical measurements
  - Certain conditions limiting for fauna

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Methods

Study Design > Sampling > Processing & Analysis

October 2012: Proof of Concept

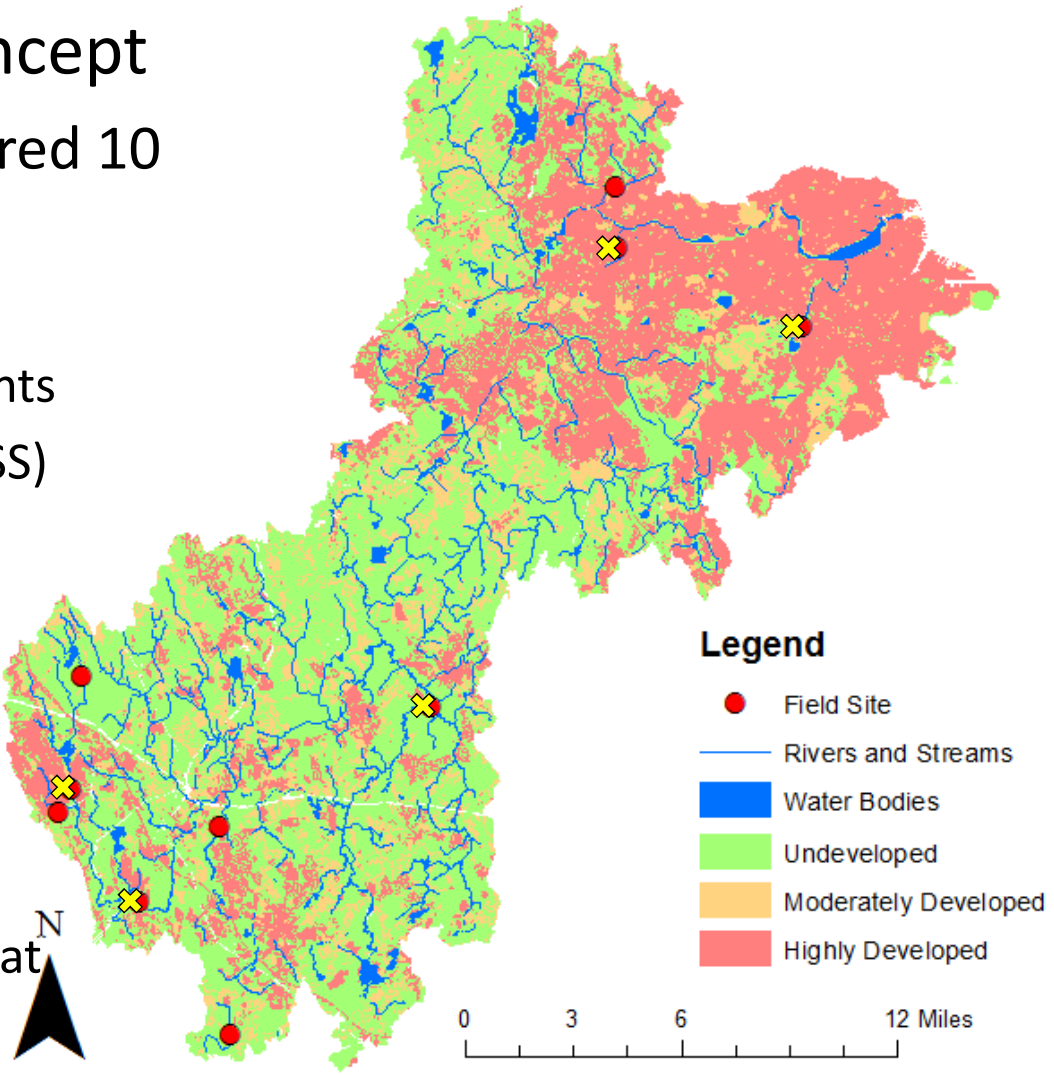
Freshwater Ecology Lab monitored 10 sites

- Macroinvertebrates
- Physical-chemical measurements
- Basin Area Stream Survey (BASS) habitat assessment
- Water samples

June 2013: Pilot Launch

Citizen scientists visited 5 sites

- Macroinvertebrates
- EPA rapid bioassessment habitat assessment



Methods

Study Design > **Sampling** > Processing & Analysis

Sites: Reaches with microhabitats representative of 100m of stream

Habitat assessment:

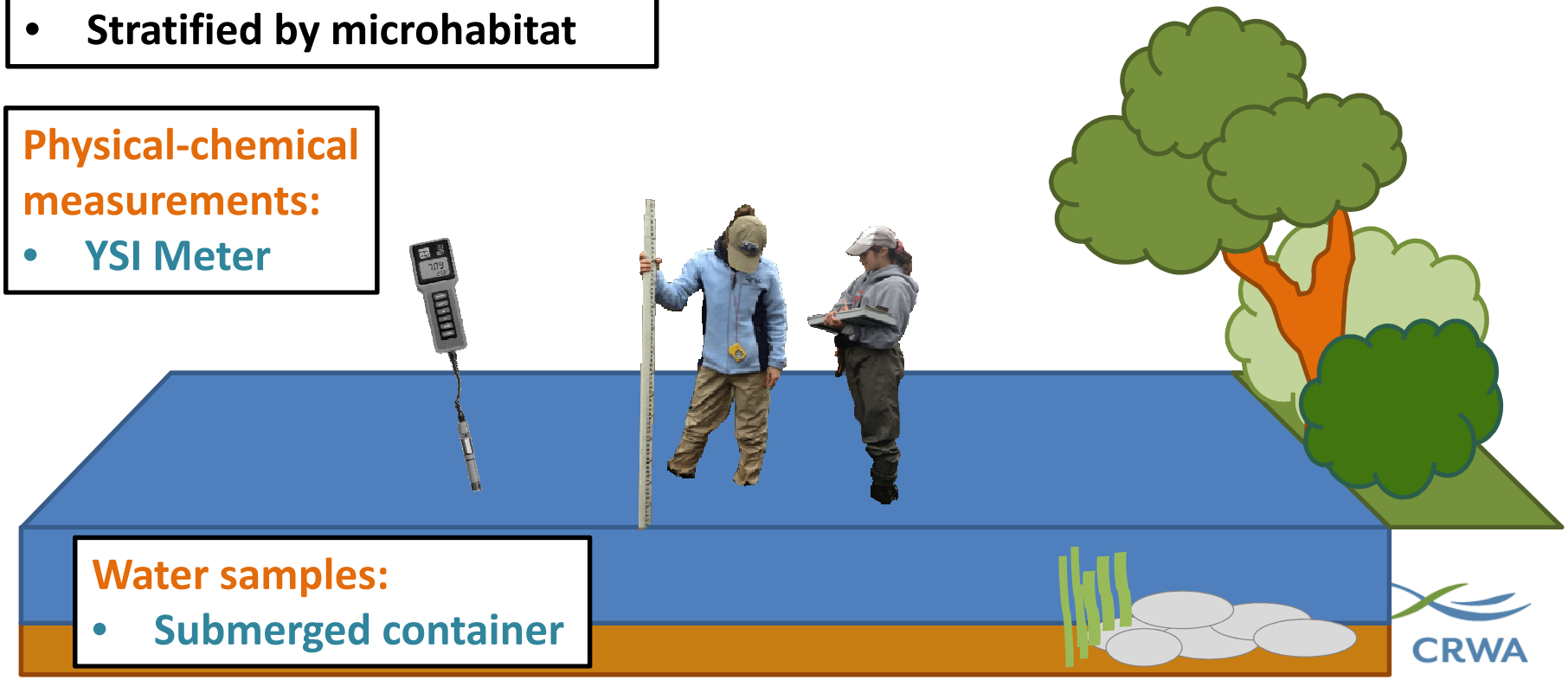
- Basin Area Stream Survey (BASS)
- US EPA Rapid Bioassessment Protocols (EPA RBP)

Macroinvertebrates:

- 20 jabs with dipnet
- Stratified by microhabitat

Physical-chemical measurements:

- YSI Meter



Water samples:

- Submerged container

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Methods

Study Design > Sampling > **Processing & Analysis**

Analyzing macroinvertebrates

Stream Biotic Index (SBI)

Sorts taxonomic groups into tolerance classes, family level identification

Presence of taxonomic groups multiplied by weighting factor

Total score categorized for water quality

EPA Streamside Biosurvey (SB)

Sorts taxonomic groups into tolerance classes, family level identification

Abundance in taxonomic groups multiplied by weighting factors

Total score categorized for water quality

Invertebrate Community Index (ICI)

Analyzed by seven metrics, genus level identification

Metric values scored by comparison to reference site values

Total score categorized for water quality by comparison to reference site total score

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Methods

Study Design > Sampling > **Processing & Analysis**

Analyzing macroinvertebrates

Stream Biotic Index (SBI)

2012 samples: collection and identification by UMass FEL

2013 samples: collection and identification by citizen scientists / QA of identification and recalculation of SBI by UMass FEL

EPA Streamside Biosurvey (SB)

2012 samples: collection and identification by UMass FEL

Invertebrate Community Index (ICI)

2012 samples: collection and identification by UMass FEL

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Results and Discussion

Evaluation of Bioassessment Methods based on 2012 Samples

Site	*A priori* Conditions	EPA Habitat	SBI	ICI - ELDS	ICI - MIBR	ICI - Best Metric	EPA SB
GOBR	Impacted	Marginal	Excellent	Not Impacted	Moderate Impact	Moderate Impact	Fair
35CS	Impacted	Marginal	Excellent	Slight Impact	Moderate Impact	Moderate Impact	Fair
90CS	Impacted	Suboptimal	Excellent	Slight Impact	Moderate Impact	Moderate Impact	Fair
MIBR	Less impacted	Suboptimal	Excellent	Slight Impact	Not Impacted	Slight Impact	Fair
MINE	Somewhat impacted	Optimal	Excellent	Slight Impact	Moderate Impact	Moderate Impact	Fair
STOP	Somewhat impacted	Suboptimal	Excellent	Slight Impact	Moderate Impact	Moderate Impact	Fair
MRBB	Highly impacted	Marginal	Good	Moderate Impact	Moderate Impact	Moderate Impact	Fair
CHBR	Highly impacted	Marginal	Good	Slight Impact	Moderate Impact	Moderate Impact	Fair
BEBR	Highly impacted	Marginal	Good	Slight Impact	Moderate Impact	Moderate Impact	Fair
ELDS	Less impacted	Suboptimal	Fair	Not Impacted	Moderate Impact	Moderate Impact	Poor

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Results and Discussion

2013

SBI: Citizen Science Identification vs. UMass FEL Identification

Site		Class I	Class II	Class III	Score	Water Quality
MRBB	Original	2	3	2	14	Fair
	QC	2	3	3	14	Fair
CHBR	Original	2	3	3	14	Fair
	QC	2	3	3	14	Fair
35CS	Original	3	5	5	21	Good
	QC	3	5	5	24	Excellent
STOP	Original	2	3	2	14	Fair
	QC	1	3	2	11	Fair

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Results and Discussion

Critically evaluate citizen science

- Re-identified macroinvertebrate samples showed **no evidence** of significant difference to citizen scientists' identifications

Per-class taxonomic groups:
(2-tail t-test, df=20, SE = 0.19, t-statistic = 0.25, p = 0.8)

Abundances within taxonomic groups:
(2-tail t-test, df=71, SE=0.78, t-statistic = 1.38, p = 0.17)

- Skill and effort dependent task performed by inexperienced, non-contracted individuals
- Many potential sources of variation, but feasible as a citizen science approach to evaluating water quality in the watershed
- If quality control needs to be universal, then citizen scientists may need additional training (and possibly certification) or could be involved through sample collection only

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Conclusions

WIN! WIN! WIN!

Charles River Watershed Association (CRWA)	UMass Boston Freshwater Ecology Lab (FEL)	Christina Ciarfella, UMass Boston student
• Technical support for volunteer training • Written monitoring protocols • Quality control of volunteer identified samples • Recommendations for future sample analysis protocols	• Connections to community groups and State monitoring personnel • Student funding • Connection to CRWA for future student work • Resource and consumer for future sampling studies • New internship program for undergraduate students	• Thesis project and committee member • Summer funding • Experience working with volunteers and writing sampling protocols

Conclusions

- Citizen science biomonitoring program currently being planned for summer 2014
- Citizen scientist will collect and identify samples
  - May add additional training and certification
- Citizen scientists will use EPA SB for analysis
- Open questions
  - Who will perform quality control?
  - Which sites will we sample again vs. addition of new sites?
  - When will we get another graduate student to help us!?

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Thank you!
Questions and Comments Welcome

Acknowledgements

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Christina Ciarfella, UMass FEL

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UMASS BOSTON

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