Urban Advantage

Formal-Informal Partnerships to Improve STEM Teaching and Learning in Middle School Science Classrooms

MICHIGAN STATE UNIVERSITY | College of Education

AMERICAN MUSEUM OF NATURAL HISTORY

DENVER MUSEUM OF NATURE & SCIENCE

urban advantage

middle school science initiative

The goal of the **Urban Advantage** program is:

To improve students' understanding of scientific knowledge and inquiry through collaborations between public school systems and informal science education institutions.


Sweet Tooth
EMERGENCY EXIT
Q3344
I.S. 25 FAMILY DAY
URBAN
ADVANTAG
AT THE BRONX
Climbing behavior
Of The
Capucnin Monkeys

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Partner Institutions

New York City Council

American Museum of Natural History

Wildlife Conservation Society Bronx Zoo

Brooklyn Botanic Garden

Wildlife Conservation Society New York Aquarium

NYC Department of Education

NYBG

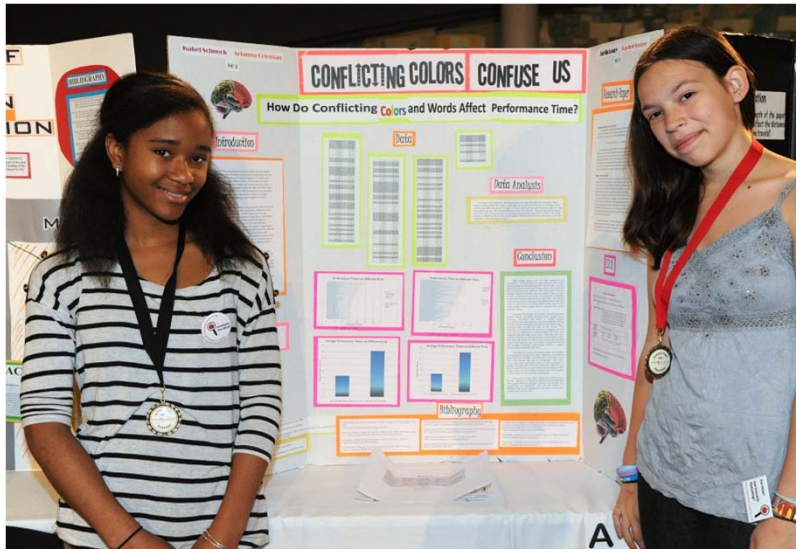
nysci New York Hall of Science

Queens Botanical Garden
Where people, plants, and cultures meet

Staten Island Zoo

urbanadvantagenyc.org

Urban Advantage - NYC
Science Exit Projects



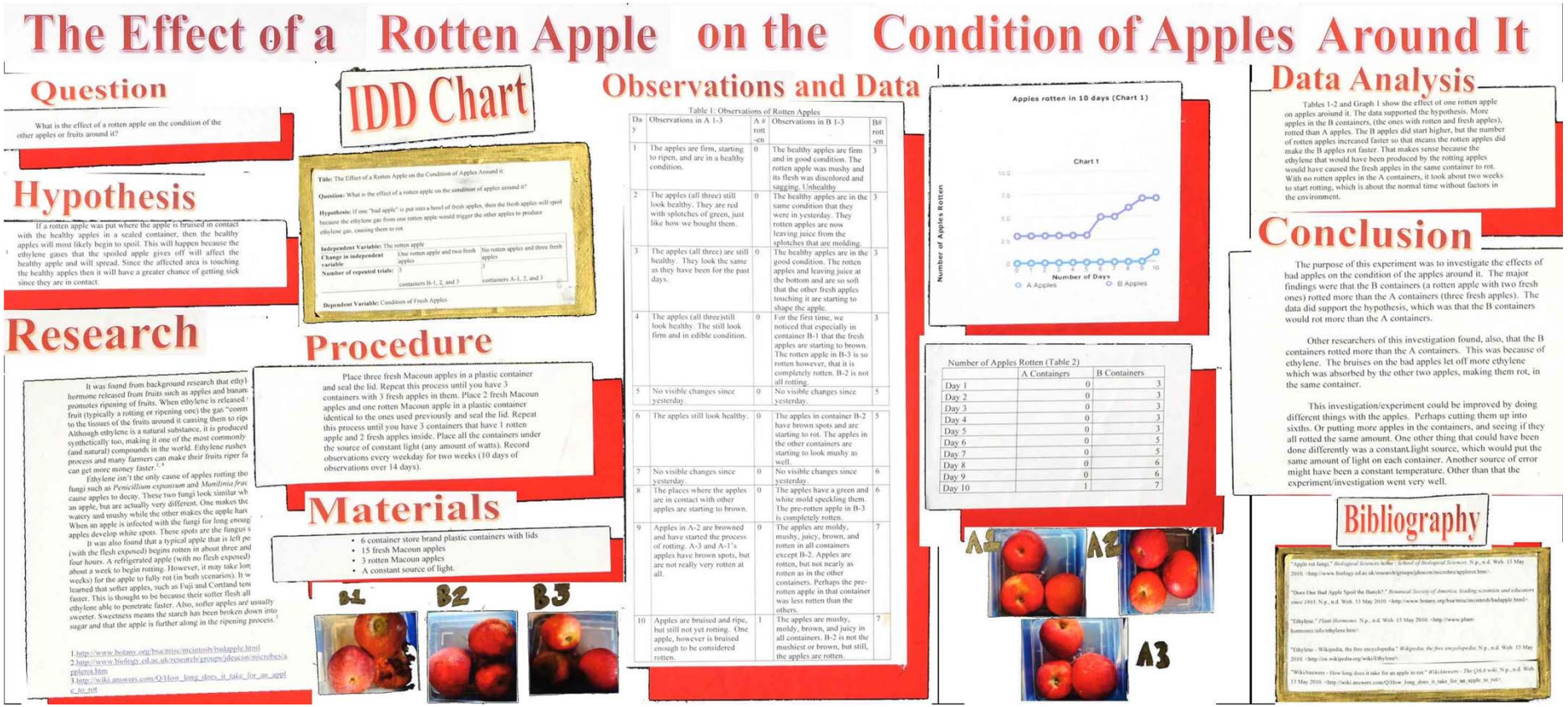
Scientific Investigation Display Board

Question	Project Title	Discussion
Hypothesis and Background Information	Names of Students School name	Scientific explanation or argument
Investigation Design	Materials and Procedure	Results Data Tables Graphs
		Conclusion
		Literature Cited

Controlled Experiments Secondary Research Projects

Field Studies Design Projects

Question: What is the effect of a rotten apple on the condition of the apples around it?



UA Framework: Six Components

Professional Development

- Workshops for science teachers and school administrators

Classroom Materials and Equipment

- Science materials/equipment for schools, teachers, & students

Access to Institutions

- Vouchers for class field trips, family field trips and visits

Outreach to Families

- Public exhibitions of student work, family science events at institutions, support for school-based family science nights

Capacity-Building and Sustainability

- Lead Teachers, Leadership Institute, Demonstration Schools

Assessment

- Program goals, student learning, and systems of delivery

COMPONENT 1
Professional Development for Teachers and Administrators

Teachers

- Immersion in inquiry workshops for new teachers
- Continuing teacher workshops

Administrators

- Science Leadership Breakfasts

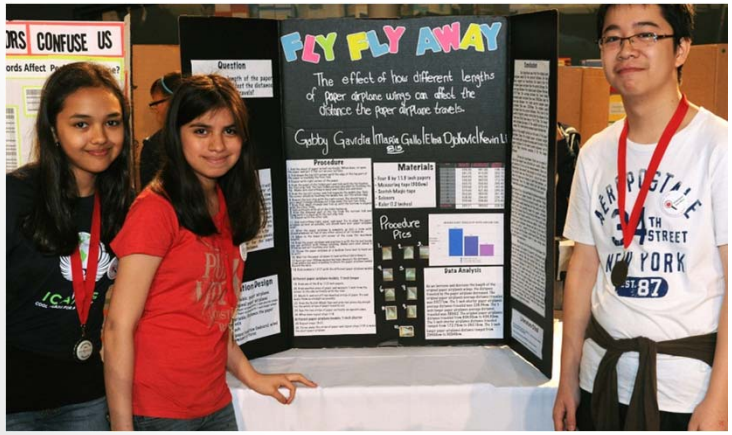
COMPONENT 2
Classroom Materials and Equipment

- Lighted plant growing environment
- Digital cameras
- Dissecting microscope
- Stopwatches
- Magnifying glasses
- Rock collections
- Field guides
- Thermometers
- Psychrometers
- Aquarium kit
- Designing rockets kit
- Water and soil field-test kits

COMPONENT 3
Access to UA Partner Institutions

- Class field trip vouchers
- Family field trip vouchers
- Student and Family vouchers
- Teacher vouchers

COMPONENT 4
Outreach to Families



- Family Science Sundays at Partner Institutions
- Parent Coordinator Workshops
- Family Science Nights at Schools
- Annual UA Science EXPO

COMPONENT 5
Capacity-Building and Sustainability

- UA Lead Science Teachers
- Leadership Institute
- Demonstration Schools

COMPONENT 6
Program Assessment and Student Learning

- Program assessment
  - Longitudinal program evaluation
  - Classroom observations
  - Teacher surveys and interviews
  - School visits
- Student learning
  - Science exit projects
  - New York State 8th grade Intermediate-Level Science Test

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Students, teachers, and families do, think, and explore like scientists —both in and out of the classroom

Metro Denver Urban Advantage is funded by the National Science Foundation's Discovery K-12 research program through grant #1020386

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The Denver Difference

- 5 Year NSF DRK-12 Efficacy Study
  - Including comprehensive evaluation
- 3 School Districts
- 3 Institutions
- 7th Grade
- Pre-Visit Program for Field Trips
- Student Leader Program

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- Supports CO State Standards
- Field trips/bus reimbursement to Museum, Zoo, and Gardens
- Teacher stipends
- Classroom materials and supplies
- Access to institutions and their scientists
- Teacher Professional Development

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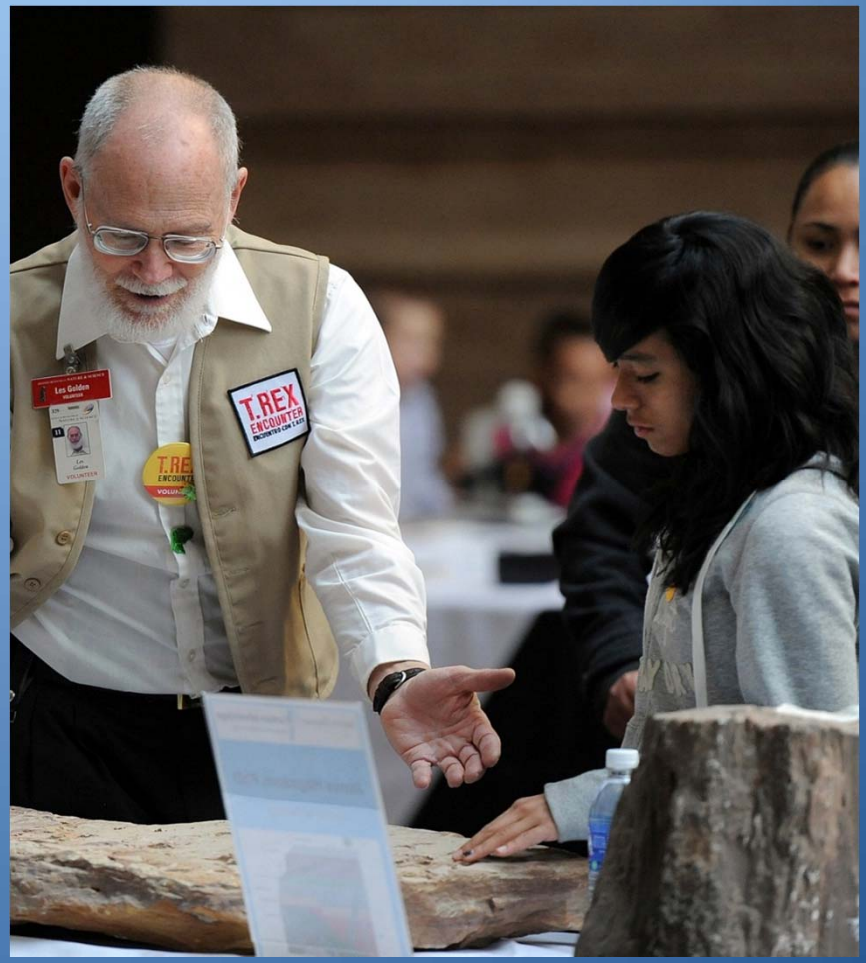
- Family Science Days @ Institutions
- Family Science Nights @ Schools
- Vouchers
- Family Guides/Materials
- Science Celebration



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The Urban Advantage Denver Research and Evaluation Team

Kathleen Tinworth, PI
Director of Visitor Research & Program Evaluation at the Denver Museum of Nature & Science

Maggie Miller, external evaluator
Maggie Miller Consulting, LLC

Erin Caldwell, lead researcher for efficacy study
National Research Center

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The Role of Evaluation in one Formal-Informal Partnership:

Metro Denver Urban Advantage

June 14, 2012

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DENVER ZOO

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The Role of Evaluation in one Formal-Informal Partnership:

Metro Denver Urban Advantage

June 14, 2012

1. Core Team
2. Field Trips
3. Vouchers

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EVALUATION GOALS

Front-End:

1. To learn from and incorporate the best practices employed in Urban Advantage New York City.

Formative / Process:

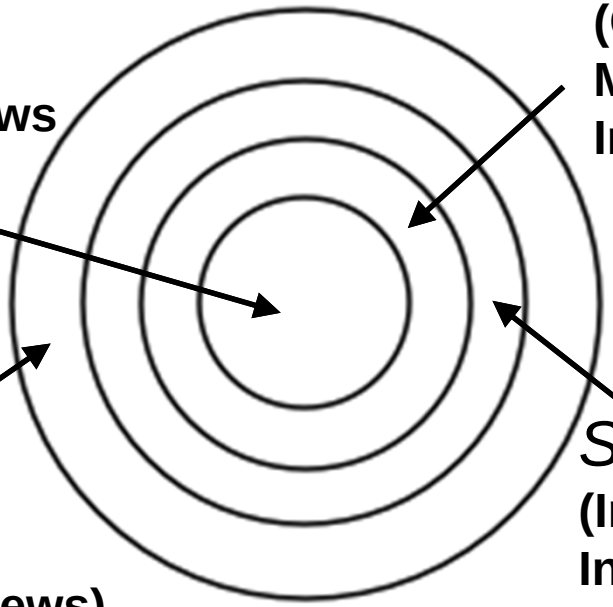
1. To examine three key areas with UA Denver program staff, students, families, and teachers: communication and expectations, feedback, and improvements needed.
2. To continue to address program goals and objectives, challenges and successes, and recommendations and changes if needed.

EVALUATION METHODS

Formative/Process:

Core Team
(Telephone Interviews & Online Surveys)

Teachers
(Online Surveys, Modified Focus Group, Interviews)



Families
(Telephone Interviews)

Students
(Intercept Surveys / Interviews &Focus Group)

Front-End: UA NYC (Telephone Interviews)

June 14, 2012

1. Core Team
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THE CORE TEAM

METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
(EVALUATION)

THE CORE TEAM: SELECTED FINDINGS

- The best things: working with other professionals and reaching a new audience
- Challenges: the number of players and the variety of schedules.
  - Difficult to achieve consistency and keep everyone involved.
- Essential:
  - A couple of people with primary responsibility
  - Meet regularly.

THE CORE TEAM

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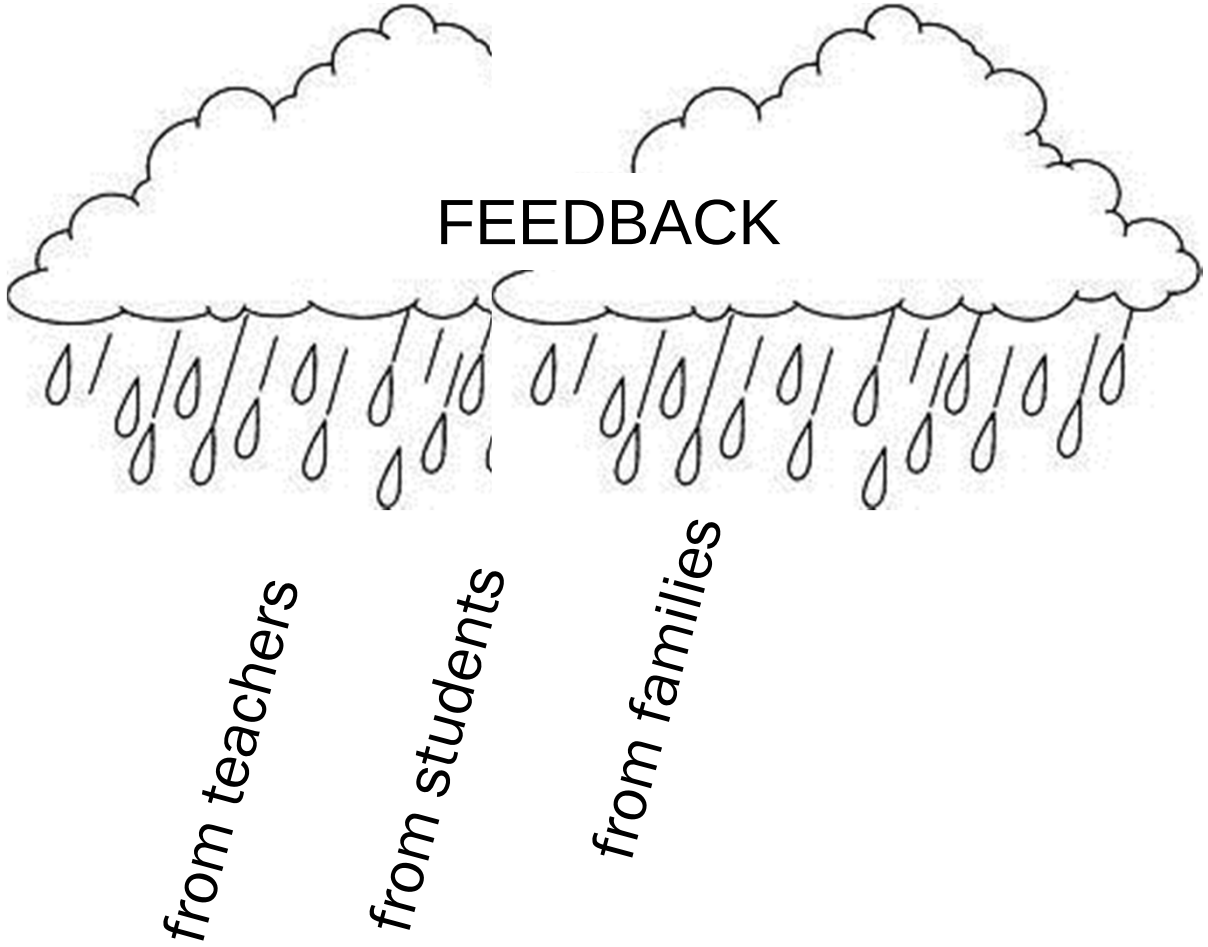
METRO DENVER URBAN ADVANTAGE MIDDLE SCHOOL SCIENCE (EVALUATION)

THE CORE TEAM



METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
(EVALUATION)

June 14, 2012

1. Core Team
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FIELD TRIPS

METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
(EVALUATION)

Field Trips (Feedback from Teachers) (Before)

What's hard about this?

- Getting enough chaperones, having chaperones that are responsible.
- What to do with a kid that misbehaves.
- Too many kids to take at one time.
- Lack of transportation.

Field Trips (Feedback from Teachers) (Before)

What can UA Denver staff do to make things easier?

- Have a representative come from the institution to the classroom.
- Provide chaperones.
- Help with training for non-science teacher chaperones.

FIELD TRIPS (FEEDBACK FROM TEACHERS) (AFTER)

- *The packet from the zoo and DBG had good information, and saved teachers time. They clearly outlined the different types of experiences.*
- *Know your audience. I know how to engage the kids. They don't give a shit about plants. Show crazy adaptations, carnivorous plants, biomes. Plants that are gross, or useful, or have personality. Medicinal uses..*

FIELD TRIPS (FEEDBACK FROM TEACHERS) (AFTER)

- *We had greater efficiency this year [than last year], and more organization for the field trips. As a result the planning for them took less time. And because our prep was more effective, more learning took place. We have a system now, with a spreadsheet to keep everything organized.*

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1. Core Team
2. Field Trips
3. Vouchers

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VOUCHERS

METRO DENVER URBAN ADVANTAGE MIDDLE SCHOOL SCIENCE (EVALUATION)

VOUCHERS

- *I didn't use them because I had baseball practice a lot, and my dad worked late nights, and on weekends. And also my mom and my stepmom work, too.*
- *I didn't use them because I have a little baby brother—one's 2 years old and one's like 6 months old, so…*

VOUCHERS

"My favorite part was when we, when I went to the zoo by myself, using those vouchers to get in for free with my family, and just by myself with my friends. It was really fun for me because I got to put family and schoolwork together so I wouldn't just be on both ones separately and feel like I'm pushing the other one aside."

Efficacy Study in one Formal-Informal Partnership: What We Are Measuring

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Aurora Public Schools

Denver Museum of Nature & Science

Denver Zoo

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RESEARCH QUESTIONS

1. Impact of Urban Advantage on
   students
2. Impact of Urban Advantage on
   teachers
3. Impact of Urban Advantage on
   families

THE METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
EFFICACY STUDY

RANDOM ASSIGNMENT OF SCHOOLS

Urban Advantage






Comparison





THE METRO DENVER URBAN ADVANTAGE
MIDDLE SCHOOL SCIENCE
EFFICACY STUDY

Data Collection Efforts

Standardized Student Science Assessment

Pre-Post Student Science Assessment

Pre-Post Student Surveys

Pre-Post Teacher Surveys

Post-only Parent Surveys

Data Collection Efforts

Standardized Student Science Assessment

Pre and Post in 7th Grade
MAP™ or NWEA Formative Assessment Item Bank

Compare Baseline
in Intervention and Control Schools/Students

Pre Post

Compare Change
in Intervention and Control Schools/Students

Assessment

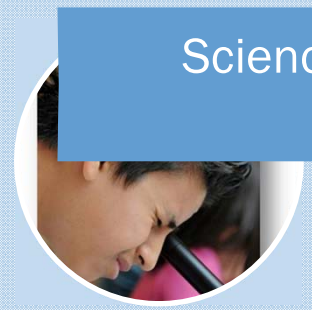
Compare 8th Grade Standardized Scores
in Intervention and Control Schools/Students

Post-only Parent Surveys

THE METRO DENVER URBAN ADVANTAGE MIDDLE SCHOOL SCIENCE EFFICACY STUDY

Data Collection Efforts

Standardized Student Science Assessment



Science Assessment

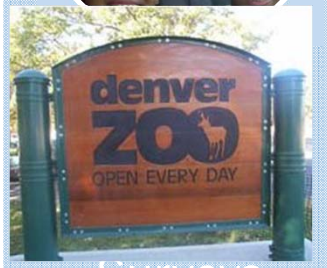
Student Surveys

Teacher Surveys

Science interest and aspirations (mATSI)

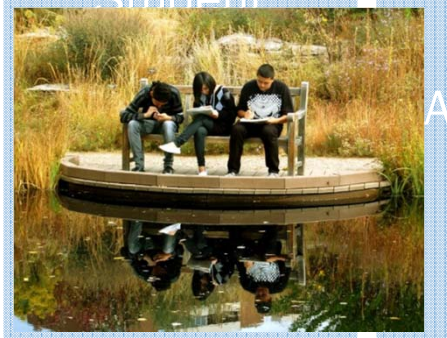
Interest in and visitation of informal institutions

Know how to do an investigation



THE METRO DENVER URBAN ADVANTAGE MIDDLE SCHOOL SCIENCE EFFICACY STUDY

Data Collection Efforts



Standardized Student

Pre-Post

Pre-Post

Pre-Post

Self-Efficacy for and Self-Reported Behaviors of Teaching Scientific Inquiry and Investigation (Teaching Science as Inquiry Instrument)

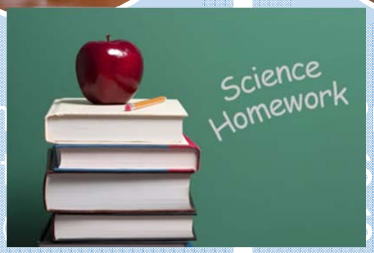
Use of Tools Trained on in TPD (DSET, PINT, EDD)

Use of Field Trip Templates and Materials

Post-only Parent Surveys

THE METRO DENVER URBAN ADVANTAGE MIDDLE SCHOOL SCIENCE EFFICACY STUDY

Data Collection Efforts



Science interest and aspirations (modified from mATSI)

Self-efficacy for helping student with science homework

Interest in and visitation of informal institutions

Assessment

Assessment

Surveys

Surveys

Post-only Parent Surveys

THE METRO DENVER URBAN ADVANTAGE MIDDLE SCHOOL SCIENCE EFFICACY STUDY

Learning Science as Inquiry with the Urban Advantage:

Formal-Informal Collaborations to Increase Science Literacy and Student Learning

NSF-funded DR-K12 Project

Jim Short, Principal Investigator, AMNH
Suzanne Wilson, Co-Principal Investigator, MSU

NSF

MICHIGAN STATE UNIVERSITY Research
Advancing knowledge. Transforming lives.

American Museum of Natural History
Gottesman Center for Science Teaching and Learning

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School Year	*2004-2005*	*2005-2006*	*2006-2007*	*2007-2008*	*2008-2009*	*2009-2010*	*2010-2011*	*2011-2012*
Schools	***31***	***111***	***129***	**156**	**147**	**174**	**156**	**137**
New Teachers	62	133	116	127	61	182	86	63
Continuing Teachers		62	94	129	196	204	285	280
Total Teachers	***62***	***195***	***210***	**256**	**257**	**386**	**371**	**343**
UA Students	***5,500***	***18,722***	***21,016***	***27,541***	**24,793**	**37,582**	**37,822**	**35,824**

Guiding Questions

- How can informal science education institutions best design resources to support teachers and students to conduct scientific investigations and better understand the nature of science?
- How are these resources then used, and to what extent and in what ways do they contribute to participants' learning?
- How are those resources then used for student learning?

Science Exit Projects

NYC Department of Education defines four types of long-term science investigations:

- Controlled Experiments
- Field Studies
- Design Projects
- **Secondary Research**

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Urban Advantage (UA) Professional Development Program

GOAL: Improve teachers' and students' understanding of scientific knowledge and inquiry through collaborations between the New York City public school system and science-rich cultural institutions

Teacher Professional Development (PD)		
Cycle 1 (2 days)	**Cycle 2 and 3 (6 days)**	**Continuing PD (2 days/year)**
Orientation session to: • Introduce four types of scientific investigations • Learn about cultural institutions and UA resources	Inquiry workshops to: • Conduct an in-depth examination of two types of scientific investigations • Complete a science exit project • Increase teachers' repertoire of field trip destinations	Inquiry workshops to: • Expand teachers' repertoires about scientific investigations and cultural institutions • Refine classroom practices and examine student work • Address difficult inquiry areas (e.g., constructing scientific explanations)

RIVER ECOLOGY

Investigating the effect of zebra mussels on the Hudson River

New York State's Hudson River has seen many changes, but perhaps none more dramatic than the arrival of the zebra mussel in 1991, and its rapid spread. Understanding environmental changes like this one means looking at the whole ecosystem: the web of interactions among organisms and their physical environment. Biologists at the Cary Institute of Ecosystem Studies have been studying the Hudson's freshwater tidal ecosystem since 1987. They look for patterns and connections in order to understand how the river is changing, and might change in the future.

This website gives you access to the actual data these scientists have collected about the river: factors like the cloudiness of the water, its temperature, and how many and what types of organisms live in it. Use the graphing tool to look for patterns that connect the dynamic parts of this ecosystem. Can you help the scientists investigate the effects of the zebra mussel invasion?

This project is a collaboration between the American Museum of Natural History and The Cary Institute of Ecosystem Studies.

Funding for this web site provided by the National Science Foundation

Grant # DRL-0918560

Explore the River

Learn about the history of the Hudson River and how scientists monitor the river's tidal freshwater ecosystem.

Learn more...

Meet the Scientists

Using video and text passages, you can learn about the work of scientists at the Cary Institute who are studying the invasion of zebra mussels in the

Get Started...

Graph the Data

Pick which factors you want to study and use this interactive tool to view them in relation to one another.

Get started...

Analyze the Data

Can you tell which factors are related? Observe any patterns? Figure out how different parts of the Hudson River ecosystem are connected?

Get started...

- 1986-2012 Hudson River Monitoring Data
- One of the longest continuous studies of a biological invasion (zebra mussel) in which research began prior to the invasion

“Nature of science” experiences and exposure to the “story” of the Hudson River’s zebra mussel invasion

American Museum of Natural History

RIVER ECOLOGY

Investigating the effect of zebra mussels on the Hudson River

TEACHER VERSION

American Museum of Natural History

RIVER ECOLOGY

Investigating the effect of zebra mussels on the Hudson River

STUDENT VERSION

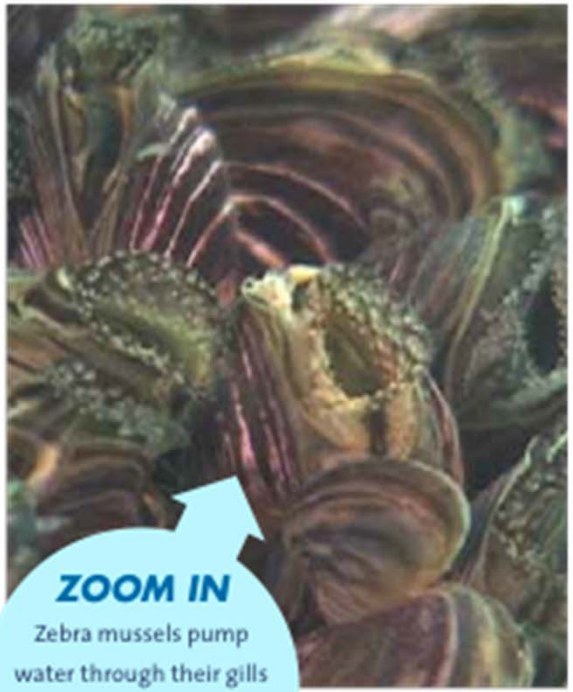
PASSAGE ONE

An Unwelcome Newcomer

Invasion of the Zebra Mussels

The zebra mussel is a small aquatic animal with two shells like a clam, named for its striped shell. This tiny creature may look harmless, but it can cause big problems. The zebra mussel is an invasive species, a species that's brought from its native area to a new place where it thrives and causes changes in the local habitats and communities.

Zebra mussels once lived only in freshwater lakes and rivers of Europe and Asia. But in the 1980s, they appeared in the Great



ZOOM IN

Zebra mussels pump water through their gills to filter out particles of food (primarily

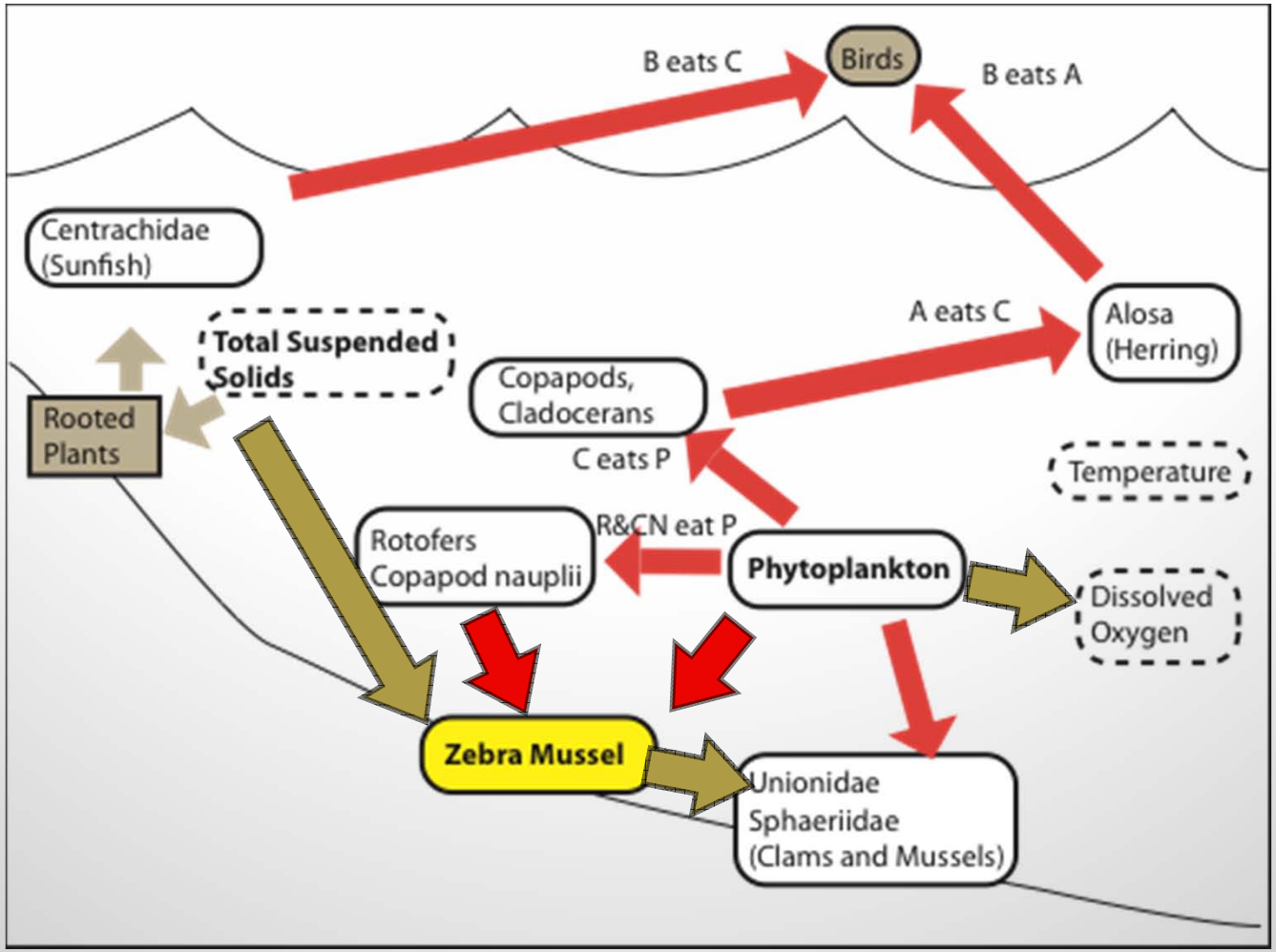
Using Museum exhibitions to engage in ecosystem concepts

In the diorama identify abiotic (non-living) and biotic components…
Using arrows, diagram one connection that might exist between abiotic and biotic components
Can you propose this connection as a question? How will….. affect……?

Out in the Field

Building an Investigation

- How will _____ affect _____?



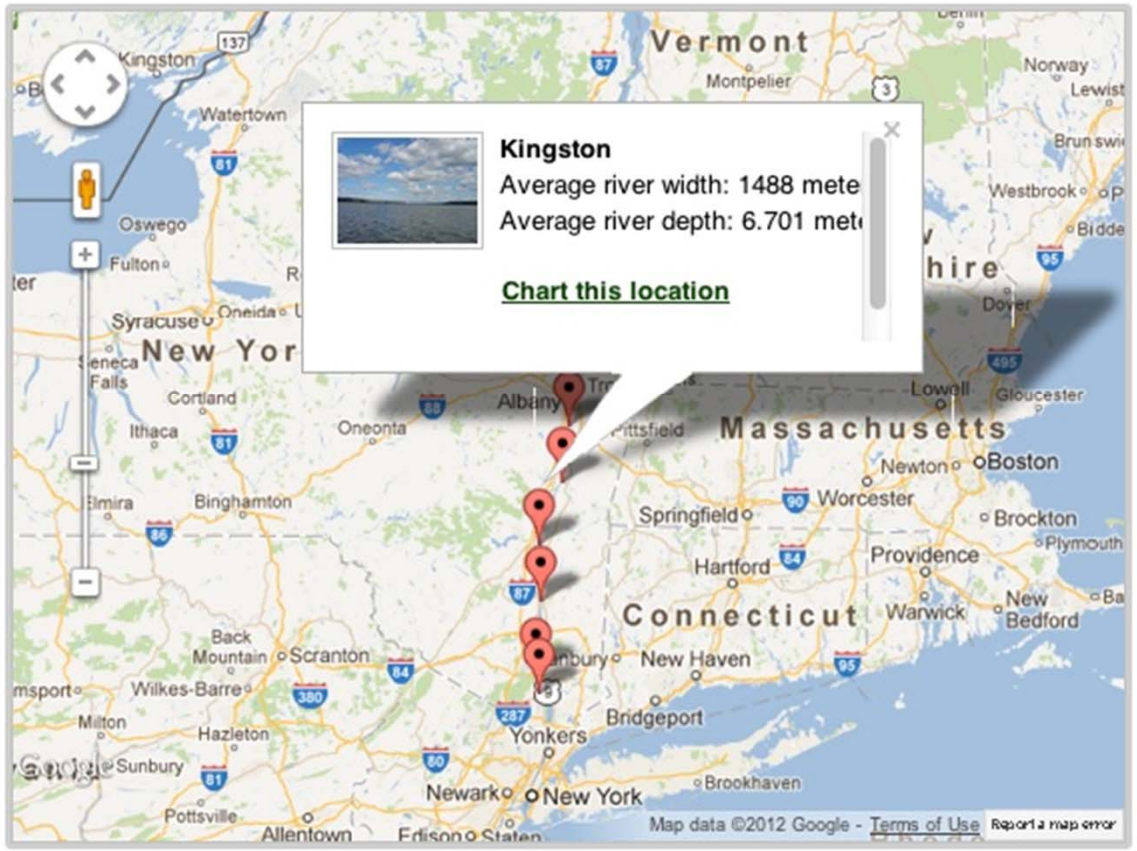
RIVER ECOLOGY

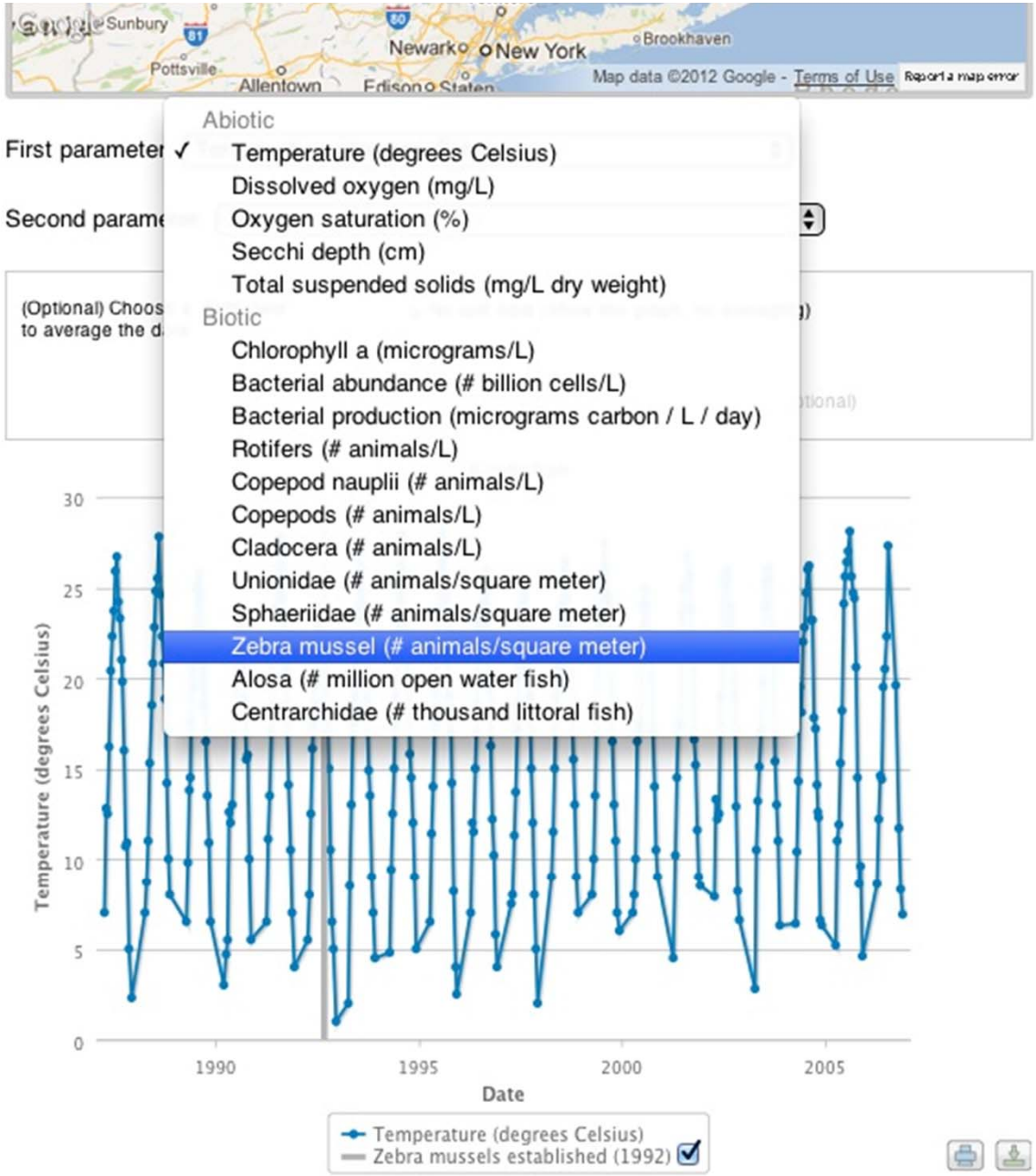
Investigating the effect of zebra mussels on the Hudson River

Graph the Data:

Over Time

1. Select a sampling station from the map below.
2. Click "Chart this location" to view data for that location.



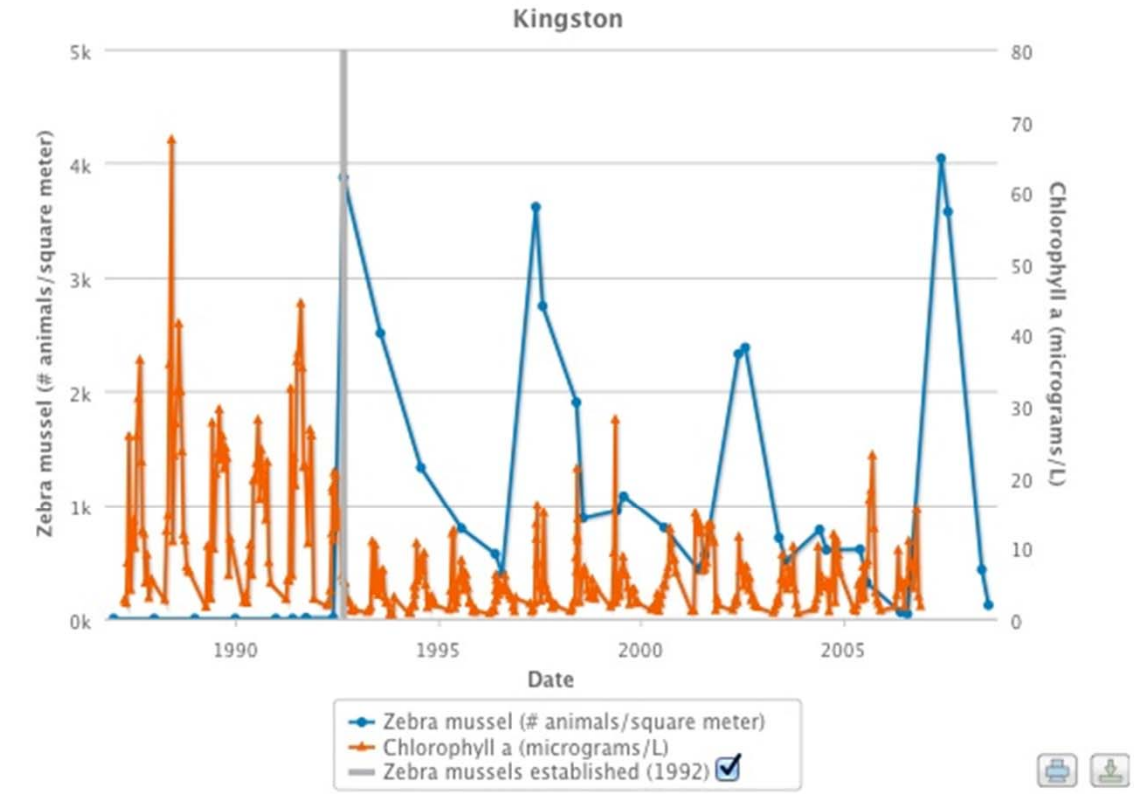

Sunbury
Pottsville
Allentown
Edison
Staten
Newark
New York
Brookhaven
Map data ©2012 Google - Terms of Use
Report a map error
First parameter
Second parame
(Optional) Choos
to average the d
Abiotic
✓ Temperature (degrees Celsius)
Dissolved oxygen (mg/L)
Oxygen saturation (%)
Secchi depth (cm)
Total suspended solids (mg/L dry weight)
Biotic
Chlorophyll a (micrograms/L)
Bacterial abundance (# billion cells/L)
Bacterial production (micrograms carbon / L / day)
Rotifers (# animals/L)
Copepod nauplii (# animals/L)
Copepods (# animals/L)
Cladocera (# animals/L)
Unionidae (# animals/square meter)
Sphaeriidae (# animals/square meter)
Zebra mussel (# animals/square meter)
Alosa (# million open water fish)
Centrarchidae (# thousand littoral fish)
Temperature (degrees Celsius)
30
25
20
15
10
5
0
1990
1995
2000
2005
Date
Temperature (degrees Celsius)
Zebra mussels established (1992)
Show/Hide the date marker using the checkbox
Drag within chart to zoom

First parameter: Zebra mussel (# animals/square meter)

Second parameter: Chlorophyll a (micrograms/L)

(Optional) Choose a "Split Date" to average the data:

- (•) No split date (Show line graph, no averaging)
- ( ) Split Date #1
- Split Date #2 (optional)



Show/Hide the date marker using the checkbox

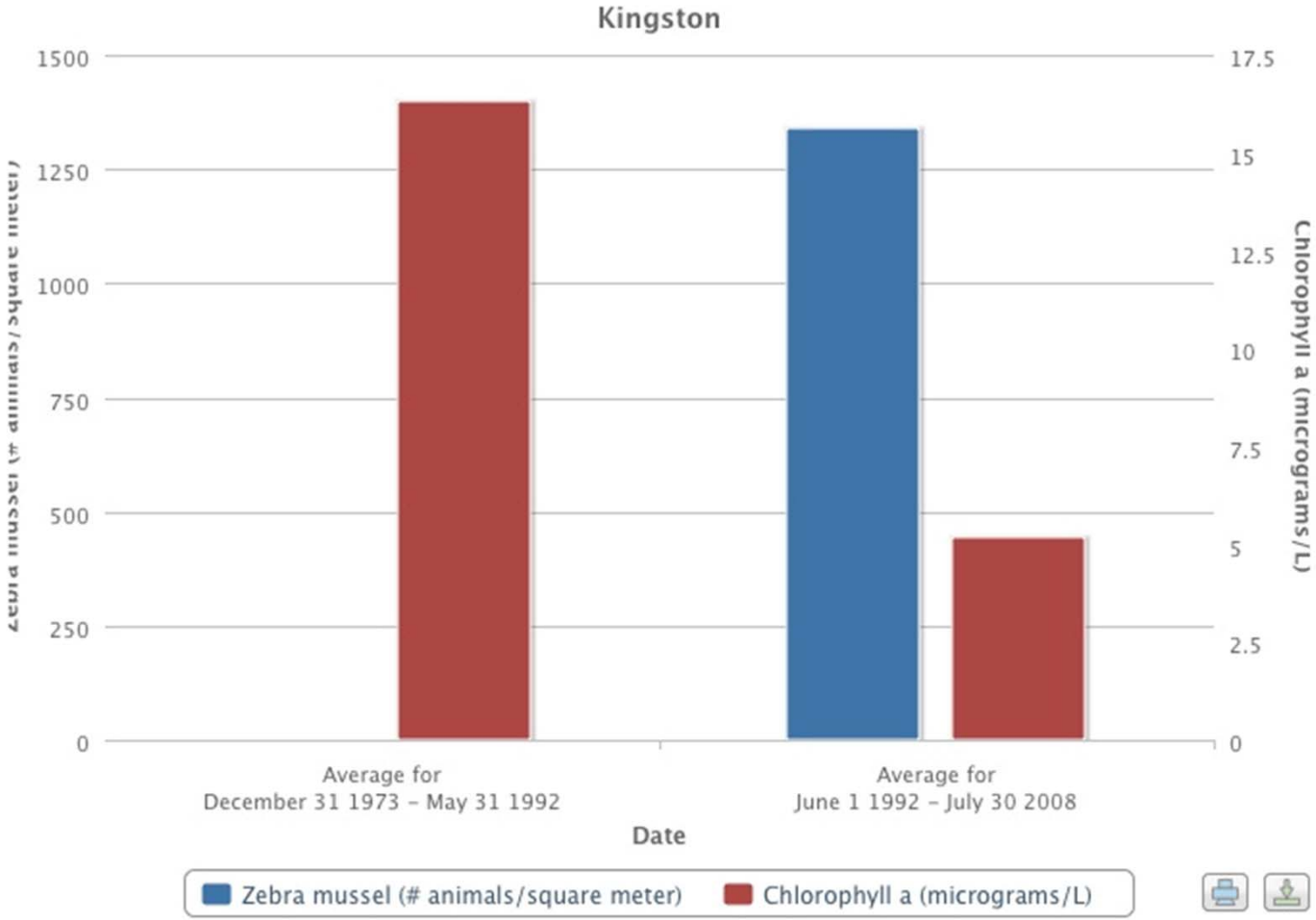
Drag within chart to zoom

First parameter: Zebra mussel (# animals/square meter)

Second parameter: Chlorophyll a (micrograms/L)

(Optional) Choose a "Split Date" to average the data:

- No split date (Show line graph, no averaging)
- Split Date #1 1992.06.01
- Split Date #2 (optional)



First parameter: Zebra mussel (# animals/square meter)

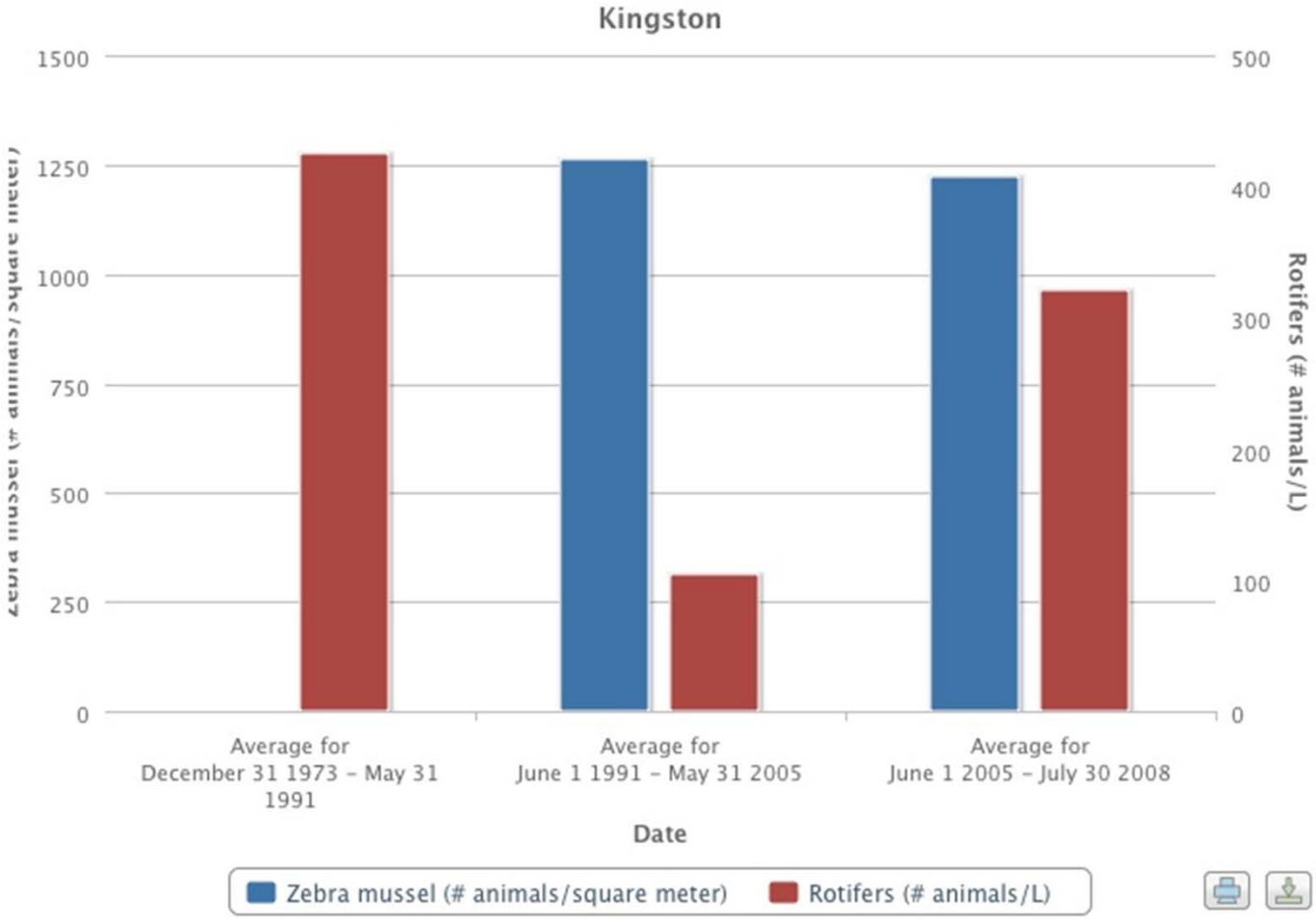
Second parameter: Rotifers (# animals/L)

(Optional) Choose a "Split Date" to average the data:

No split date (Show line graph, no averaging)

Split Date #1 1991.06.01

Split Date #2 2005.06.01 (optional)



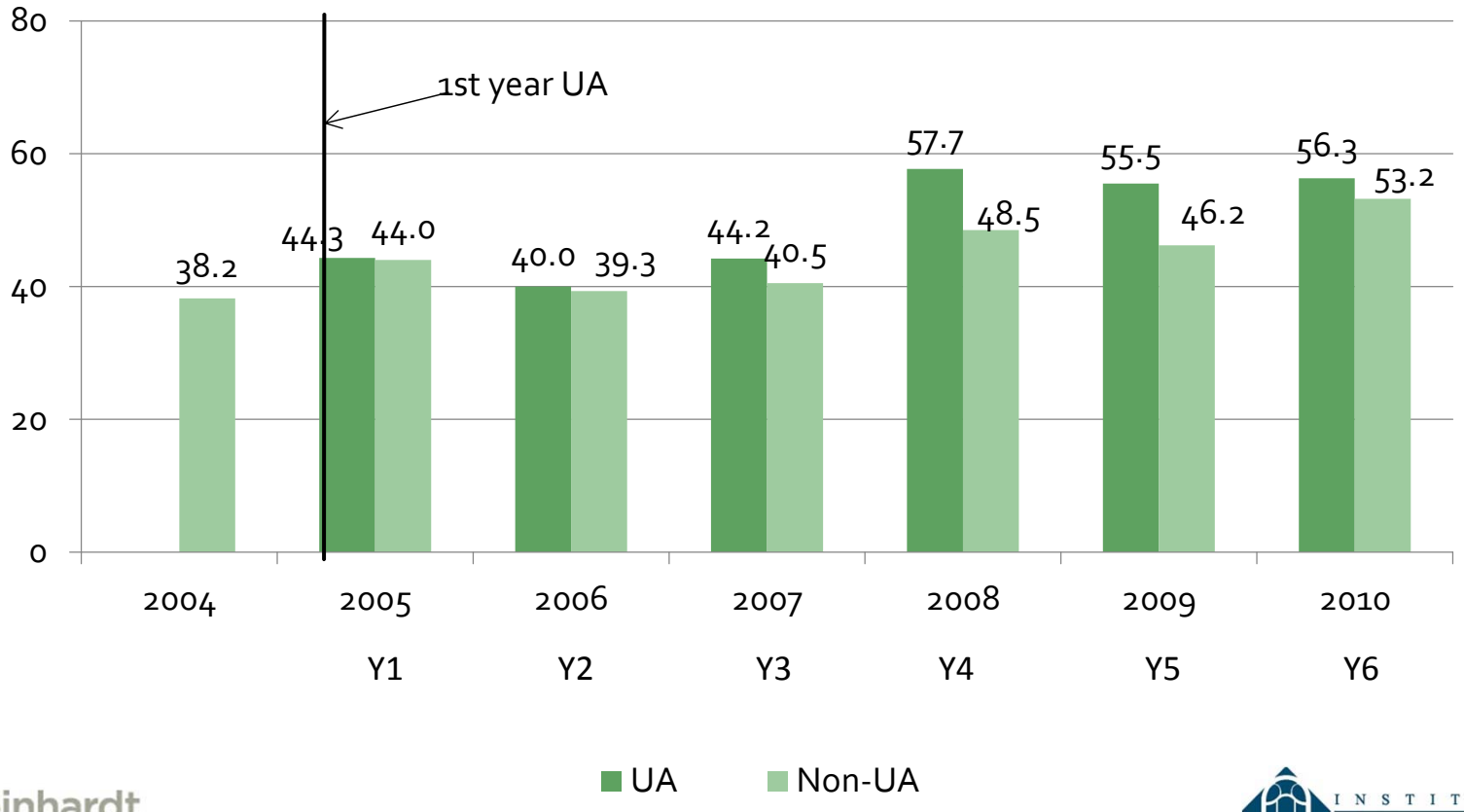
AMERICAN MUSEUM OF NATURAL HISTORY

River Ecology Teaching Case

amnh.org/education/hudsonriver

Raw performance data suggests UA is effective

Student Weighted Mean Achievement, 8th Grade Intermediate Level Science (ILS) Test – Percent Proficient



NYUSteinhardt
Steinhardt School of Culture, Education, and Human Development

INSTITUTE FOR Education and Social Policy

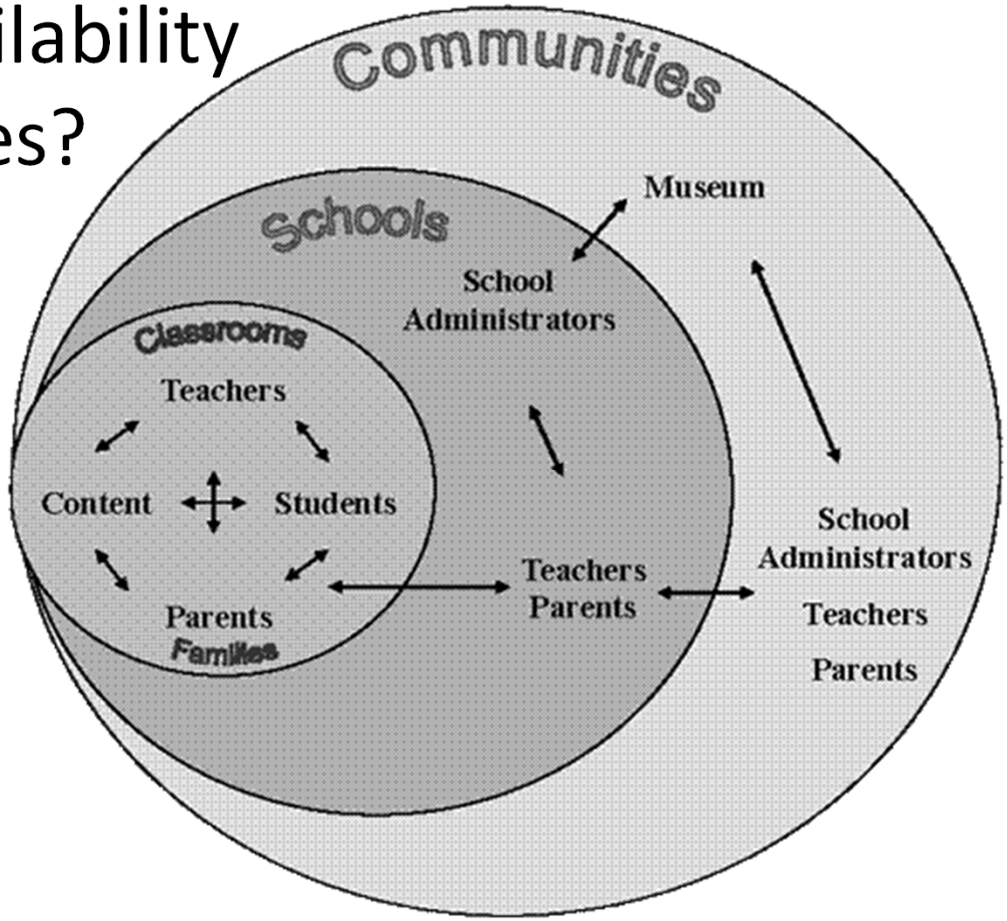
Teaching Teachers Science: The Case of Urban Advantage

Principal Investigators: James Short (AMNH) and Suzanne M. Wilson (MSU)

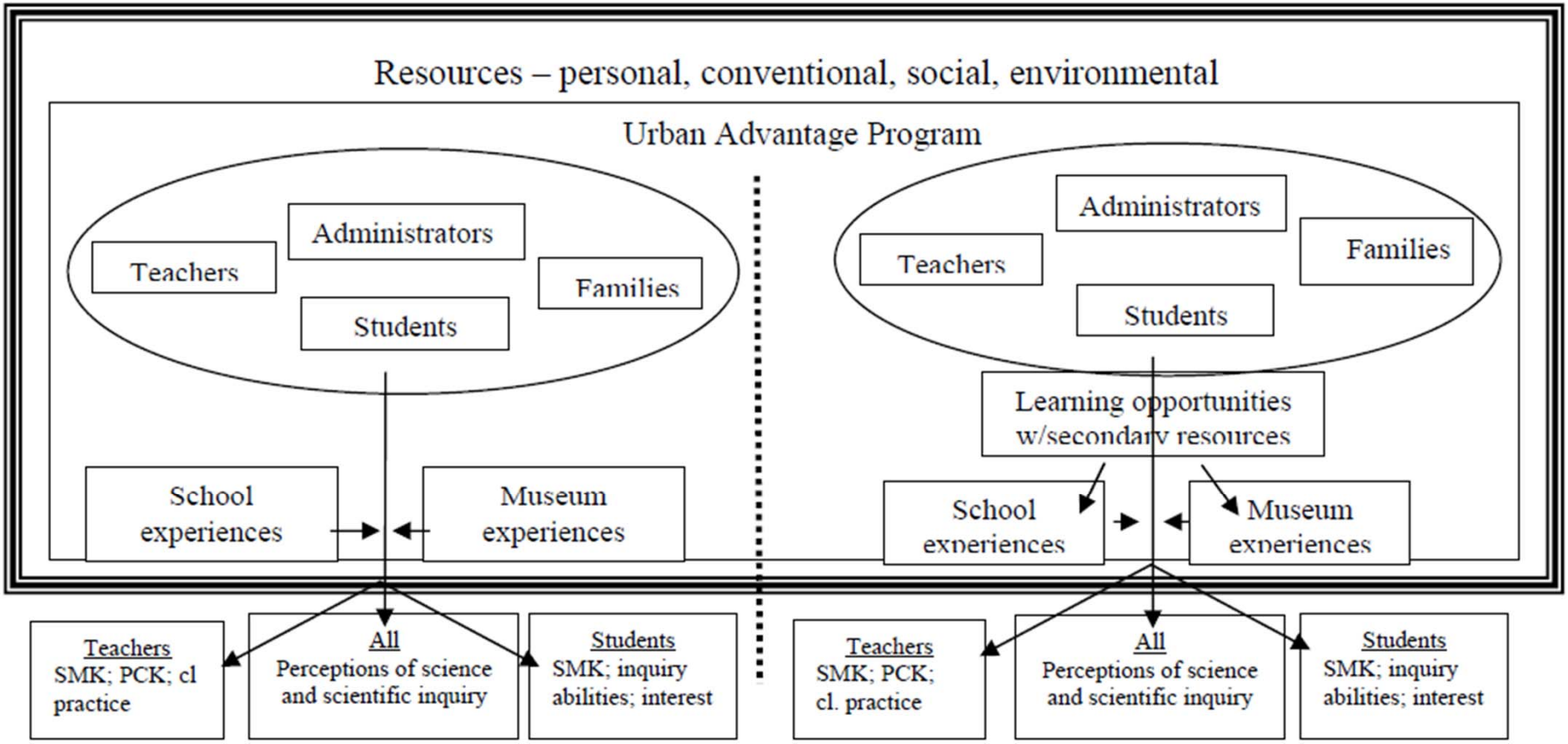
Research Team: Jamie N. Mikeska, Patricia Bills, Kenne Dibner, Suzanne Elgendy, Mark Helmsing, Tamara Shattuck, Amber Meyer

Research Project

- How are teachers' developing understanding and practice and their students' learning enabled by the availability and use of resources?



Research Design



Methods

- Sample: First cohort of middle school science teachers (n=15) attending UA PD in fall 2010
- Data sources included:
  - PD observations
  - Classroom observations
  - Teacher interviews
- Qualitative data analysis involved:
  - Coding and linking together data segments
  - Memoing
  - Content analyses of field notes and interviews
  - Graphic mapping

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Analysis: Teachers' PD Learning Opportunities

Guiding Question: How are these resources used?

- Observed PD sessions and completed structured observation protocol describing each PD activity
- Coded each PD activity for:
  - Opportunities to do science
  - Opportunities to understand the nature of science (NOS)
  - Opportunities to understand the nature of scientific inquiry (NOSI)

Analysis: Evidence of Teachers' Learning

Guiding Question: What do teachers learn?

- In science exit projects
  - Breadth and depth of teachers' *communicated understanding* of scientific content
  - Use of scientific reasoning to determine clear, logical investigative steps throughout project
- In classroom instruction
  - Ideas about science inquiry and pedagogy
  - Sense-making of UA resources and tools

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Findings: Teachers' PD Learning Opportunities

- UA creates opportunities for teachers to watch science being conducted and to do science themselves
- UA resources (e.g., teaching case materials, IDD, DSET) used as an integral part of this work
- Challenge is to help teachers "go meta"

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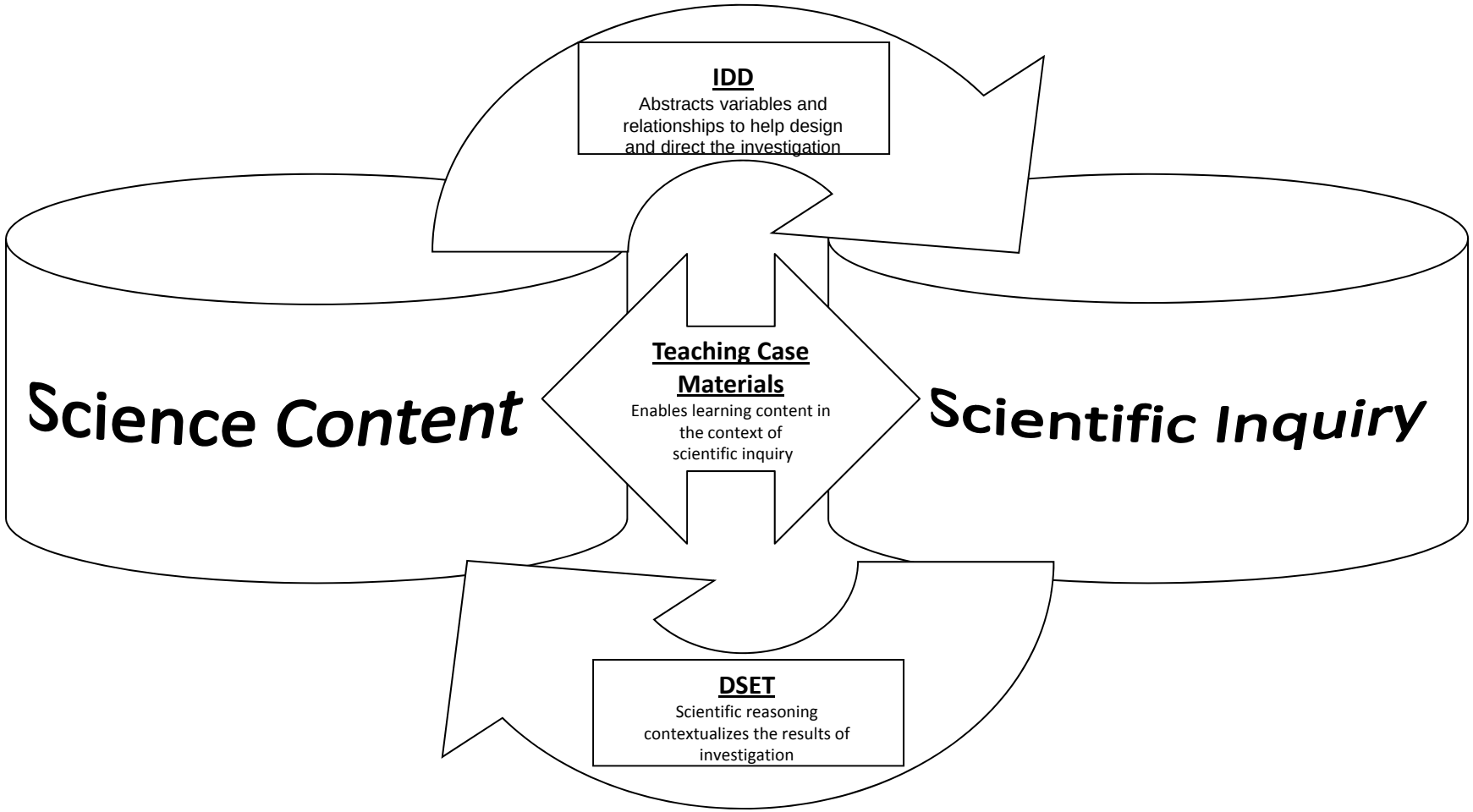
Findings: Teachers' Learning

- Quality of exit projects varies considerably *across* projects but remains largely consistent *within* projects
- Immediate appropriation of tools and language into practice
- Teachers use UA resources to support their attempts to teach inquiry:
  - As structures that guide long-term investigations
  - As supports for other curriculum activities

Interplay between Science Content and Scientific Inquiry



Theory of Teacher Learning and Change

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Continued Work

- Development work
  - Refine PD model and teaching case materials
  - Pilot and refine student materials
- Research work
  - Create teacher resource maps
  - Extend analysis to include student learning and teacher learning in other cohorts and PD cycles

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Panel Discussion

- T*hinking about accountability and outcome*s.
-
- E*ffects of studying something*.
-
- H*ow formal/informal partnerships need to have an "it" to focus their joint work*.