

# 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**



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.*





# urban advantage

middle school science initiative

## Partner Institutions



New York  
City Council

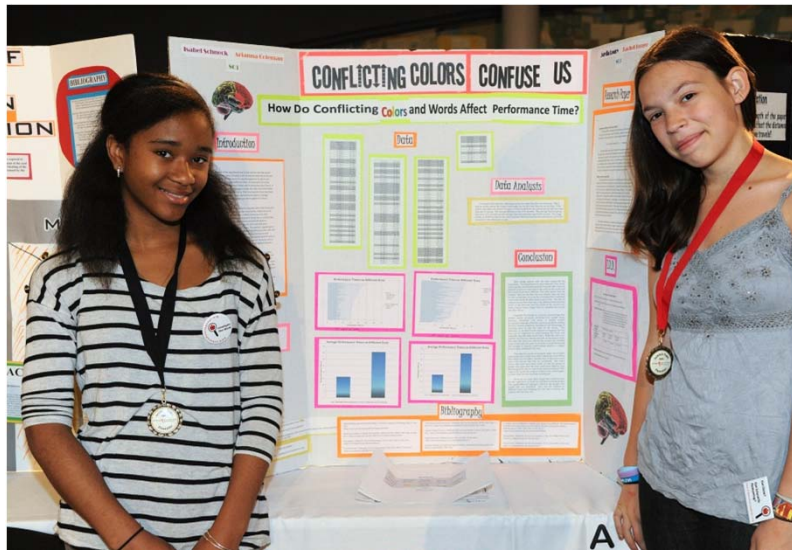


New York Hall of Science



[urbanadvantagenyc.org](http://urbanadvantagenyc.org)

# Urban Advantage - NYC Science Exit Projects



**Scientific Investigation Display Board**

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

## The Effect of a Rotten Apple on the Condition of Apples Around It

### Question

What is the effect of a rotten apple on the condition of the other apples or fruits around it?

### Hypothesis

If a rotten apple was put where the apple is bruised in contact with the healthy apples in a sealed container, then the healthy apples will most likely begin to spoil. This will happen because the ethylene gases that the spoiled apple gives off will affect the healthy apples and will spread. Since the affected area is touching the healthy apples then it will have a greater chance of getting sick since they are in contact.

### Research

It was found from background research that ethylene hormone released from fruits such as apples and bananas promotes ripening of fruits. When ethylene is released, fruit typically begins to ripen. The gas "comes" to the tissues of the fruits around it causing them to ripen. Although ethylene is a natural substance, it is produced synthetically too, making it one of the most commonly (and naturally) compounds in the world. Ethylene rushes process and many farmers can make their fruits ripen faster and get more money faster.<sup>1,2</sup>

Ethylene isn't the only cause of apples rotting. The fungi such as *Penicillium expansum* and *Monilia fructigena* cause apples to decay. These two fungi look similar, but are actually very different. One makes the apple watery and mushy while the other makes the apple hard and watery with white spots. These spots are the fungus's apples developing white spots. These spots are the fungus's apples developing white spots.

It was also found that a typical apple that is left in a refrigerator begins to rot in about three and a half weeks. A refrigerated apple (with no flesh exposed) about a week to begin rotting. However, it may take long enough for the apple to fully rot in both scenarios. It is faster. This is thought to be because their softer flesh all ethylene able to penetrate faster. Also, softer apples are usually sweeter. Sweetness means the starch has been broken down into sugar and that the apple is further along in the ripening process.<sup>3</sup>

1. <http://www.bbc.com/news/health-12041001>  
2. <http://www.bbc.com/news/health-12041001>  
3. <http://www.bbc.com/news/health-12041001>

### IDD Chart

Title: The Effect of a Rotten Apple on the Condition of Apples Around It

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

Hypothesis: If one "bad apple" is put into a bowl of fresh apples, then the fresh apples will spoil because the ethylene gas from one rotten apple would trigger the other apples to produce ethylene gas, causing them to rot.

Independent Variable: The rotten apple  
Change in independent variable: One rotten apple and two fresh apples  
Number of repeated trials: 3  
Containers B-1, 2, and 3

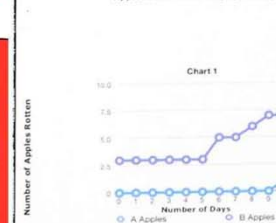
No rotten apples and three fresh apples  
Containers A-1, 2, and 3

Dependent Variable: Condition of Fresh Apples

### Observations and Data

Table 1: Observations of Rotten Apples		
Day	Observations in A 1-3	Observations in B 1-3
1	The apples are firm, starting to ripen, and are in a healthy condition.	The healthy apples are firm and in good condition. The rotten apple was mushy and its flesh was discolored and sagging. Unhealthy.
2	The apples (all three) still look healthy. They are red with splashes of green, just like how we bought them.	The healthy apples are in the same condition that they were in yesterday. They rotten apples are now leaving juice from the splashes that are rotting.
3	The apples (all three) are still healthy. They look the same as they have been for the past days.	The healthy apples are in the good condition. The rotten apples and leaving juice at the bottom and are so soft that the other fresh apples touching it are starting to shape the apple.
4	The apples (all three) still look healthy. The still look firm and in edible condition.	For the first time, we noticed that especially in container B-1 that the fresh apples are starting to brown. The rotten apple in B-3 is so rotten however, that it is completely rotten. B-2 is not all rotting.
5	No visible changes since yesterday.	No visible changes since yesterday.
6	The apples still look healthy.	The apples in container B-2 have brown spots and are starting to rot. The apples in the other containers are starting to look mushy as well.
7	No visible changes since yesterday.	No visible changes since yesterday.
8	The places where the apples are in contact with other apples are starting to brown.	The apples have a green and white mold speckling them. The pre-rotten apple in B-3 is completely rotten.
9	Apples in A-2 are browned and have started the process of rotting. A-3 and A-1's apples have brown spots, but are not really very rotten at all.	The apples are moldy, mushy, juicy, brown, and rotten in all containers except B-2. Apples are rotten, but not nearly as rotten as in the other containers. Perhaps the pre-rotten apple in that container was less rotten than the others.
10	Apples are bruised and ripe, but still not yet rotting. One apple, however is bruised enough to be considered rotten.	The apples are mushy, moldy, brown, and juicy in all containers. B-2 is not the mushiest or brown, but still, the apples are rotten.

Apples rotten in 10 days (Chart 1)



Number of Apples Rotten (Table 2)		
Day	A Containers	B Containers
Day 1	0	3
Day 2	0	3
Day 3	0	3
Day 4	0	3
Day 5	0	3
Day 6	0	5
Day 7	0	5
Day 8	0	6
Day 9	0	6
Day 10	1	7

### Data Analysis

Tables 1-2 and Graph 1 show the effect of one rotten apple on apples around it. The data supported the hypothesis. More apples in the B containers, (the ones with rotten and fresh apples), rotted than A apples. The B apples did start higher, but the number of rotten apples increased faster so that means the rotten apples did make the B apples rot faster. That makes sense because the ethylene that would have been produced by the rotting apples would have caused the fresh apples in the same container to rot. With no rotten apples in the A containers, it took about two weeks to start rotting, which is about the normal time without factors in the environment.

### Conclusion

The purpose of this experiment was to investigate the effects of bad apples on the condition of the apples around it. The major findings were that the B containers (a rotten apple with two fresh ones) rotted more than the A containers (three fresh apples). The data did support the hypothesis, which was that the B containers would rot more than the A containers.

Other researchers of this investigation found, also, that the B containers rotted more than the A containers. This was because of ethylene. The bruises on the bad apples let off more ethylene which was absorbed by the other two apples, making them rot, in the same container.

This investigation/experiment could be improved by doing different things with the apples. Perhaps cutting them up into sixths. Or putting more apples in the containers, and seeing if they all rotted the same amount. One other thing that could have been done differently was a constant light source, which would put the same amount of light on each container. Another source of error might have been a constant temperature. Other than that the experiment/investigation went very well.

### Bibliography

- "Apples on Apple." *Biological Sciences*. School of Biological Sciences. N.p., n.d. Web. 13 May 2010. <<http://www.biology.ed.ac.uk/research/groups/biology/biology.html>>
- "Does the Bad Apple Spoil the Batch?" *Botanical Society of America*. leading scientists and educators since 1903. N.p., n.d. Web. 13 May 2010. <<http://www.botanicalsociety.org/botanicalsociety.html>>
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- "Ethylene." *How long does it take for an apple to rot?* *Wikipedia*. The (old) wiki. N.p., n.d. Web. 13 May 2010. <[http://wiki.answers.com/Q/How\\_long\\_does\\_it\\_take\\_for\\_an\\_apple\\_to\\_rot](http://wiki.answers.com/Q/How_long_does_it_take_for_an_apple_to_rot)>



# 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

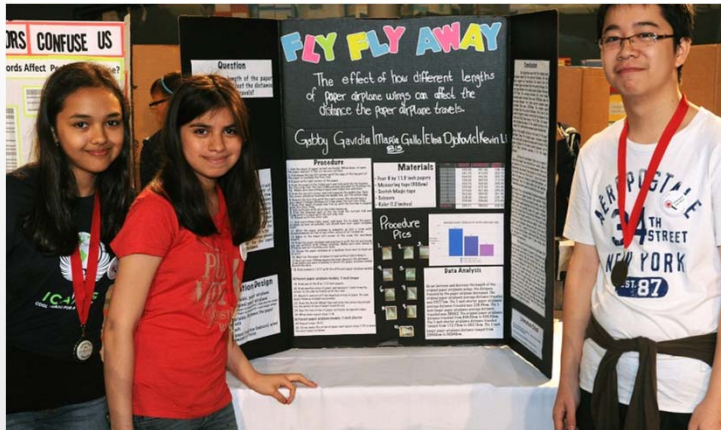
### Access to UA Partner Institutions

- 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 8<sup>th</sup> grade Intermediate-Level Science Test

# metro Denver urban advantage

middle school science initiative

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



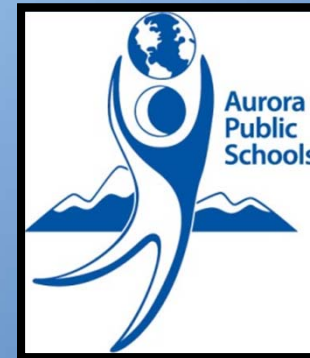
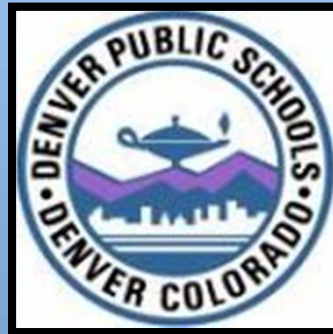


## The Denver Difference

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

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middle school science initiative



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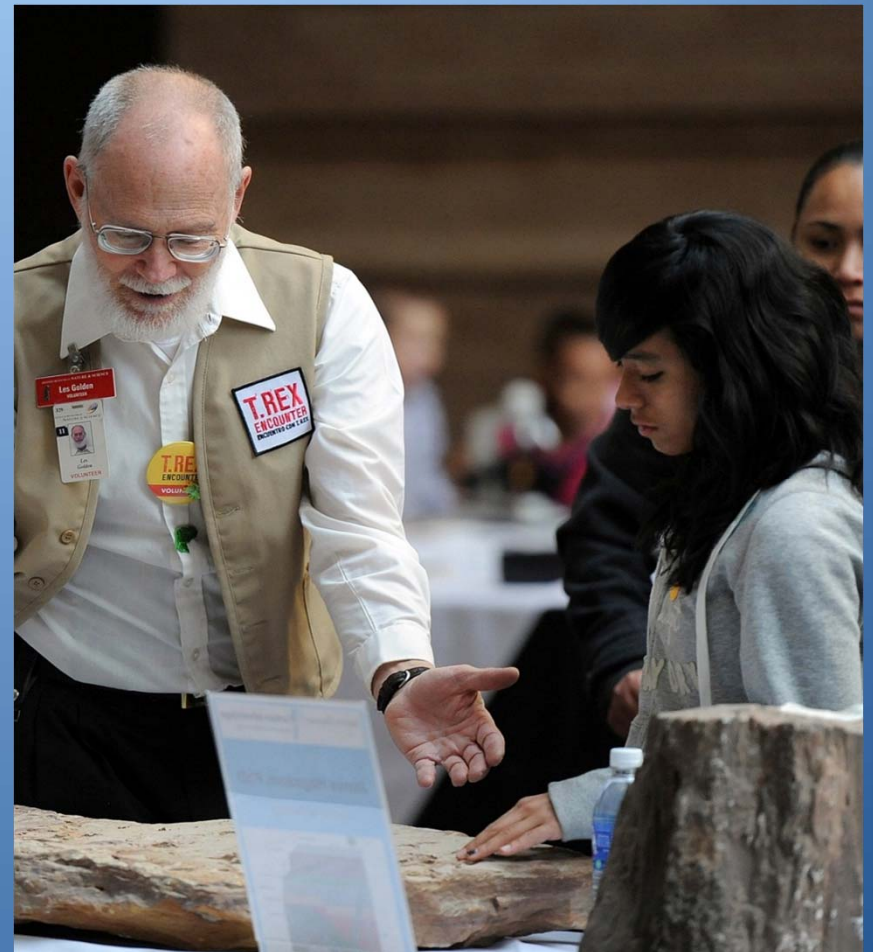
- Supports CO State Standards
- Field trips/bus reimbursement to Museum, Zoo, and Gardens
- Teacher stipends
- Classroom materials and supplies
- Access to institutions and their scientists
- Teacher Professional Development



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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

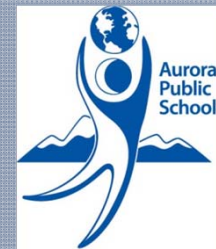
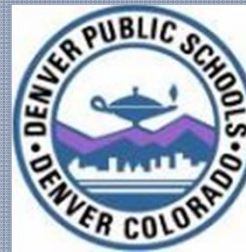
# THE ROLE OF EVALUATION IN ONE FORMAL-INFORMAL PARTNERSHIP:

**METRO DENVER  
URBAN ADVANTAGE**

JUNE 14, 2012



PARTNERED WITH:



Metro Denver Urban Advantage is funded by the National Science Foundation's Discovery K-12 Research Program through grant # DRL 1020386.



# THE ROLE OF EVALUATION IN ONE FORMAL-INFORMAL PARTNERSHIP:

**METRO DENVER  
URBAN ADVANTAGE**

JUNE 14, 2012

- 1. CORE TEAM**
- 2. FIELD TRIPS**
- 3. VOUCHERS**

Metro Denver Urban Advantage is funded by the National Science Foundation's Discovery K-12 Research Program through grant # DRL 1020386.


# EVALUATION GOALS

## Front-End:

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

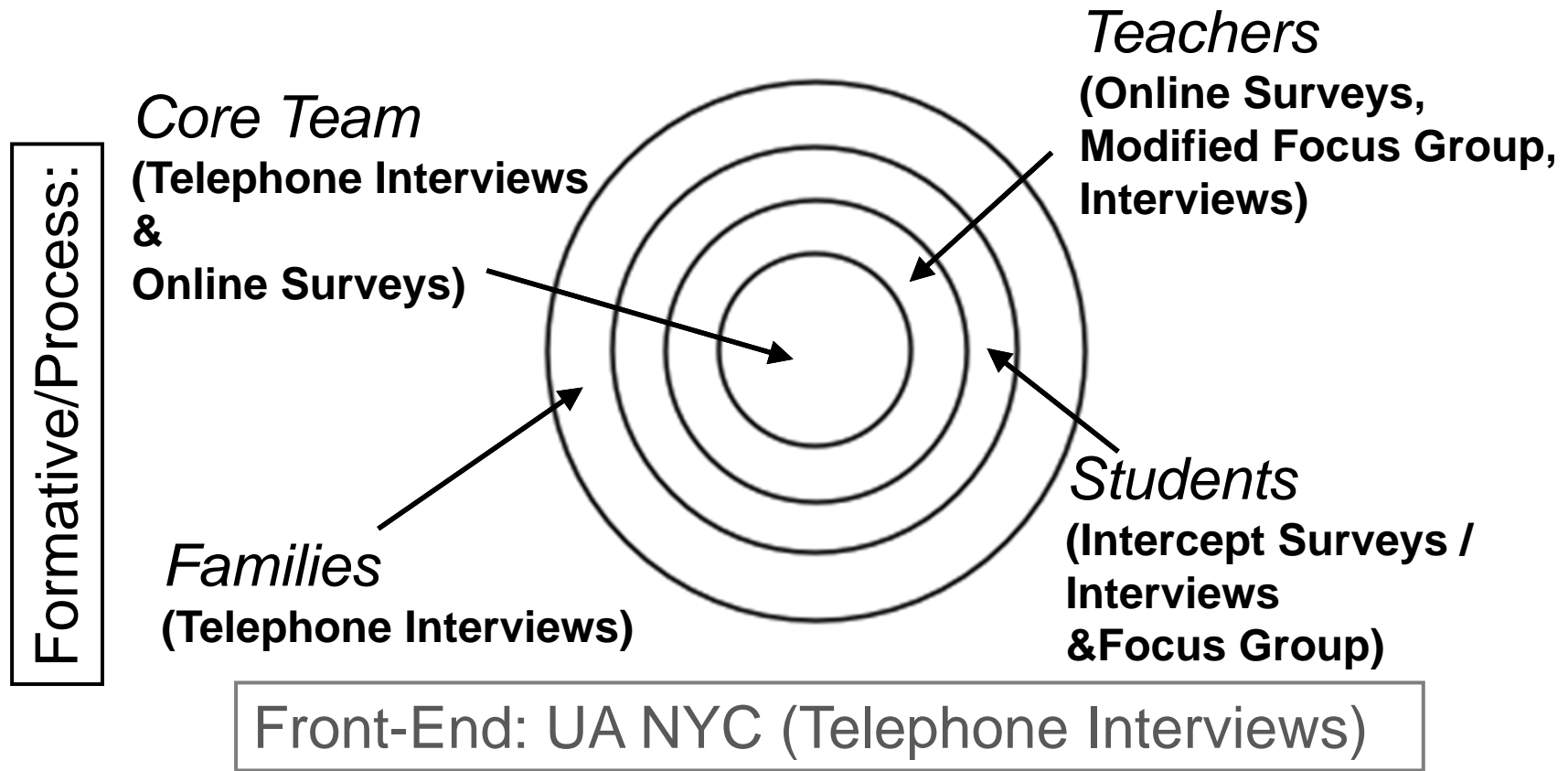
## Formative / Process:

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.



METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)

# EVALUATION METHODS



METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)



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.



METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)

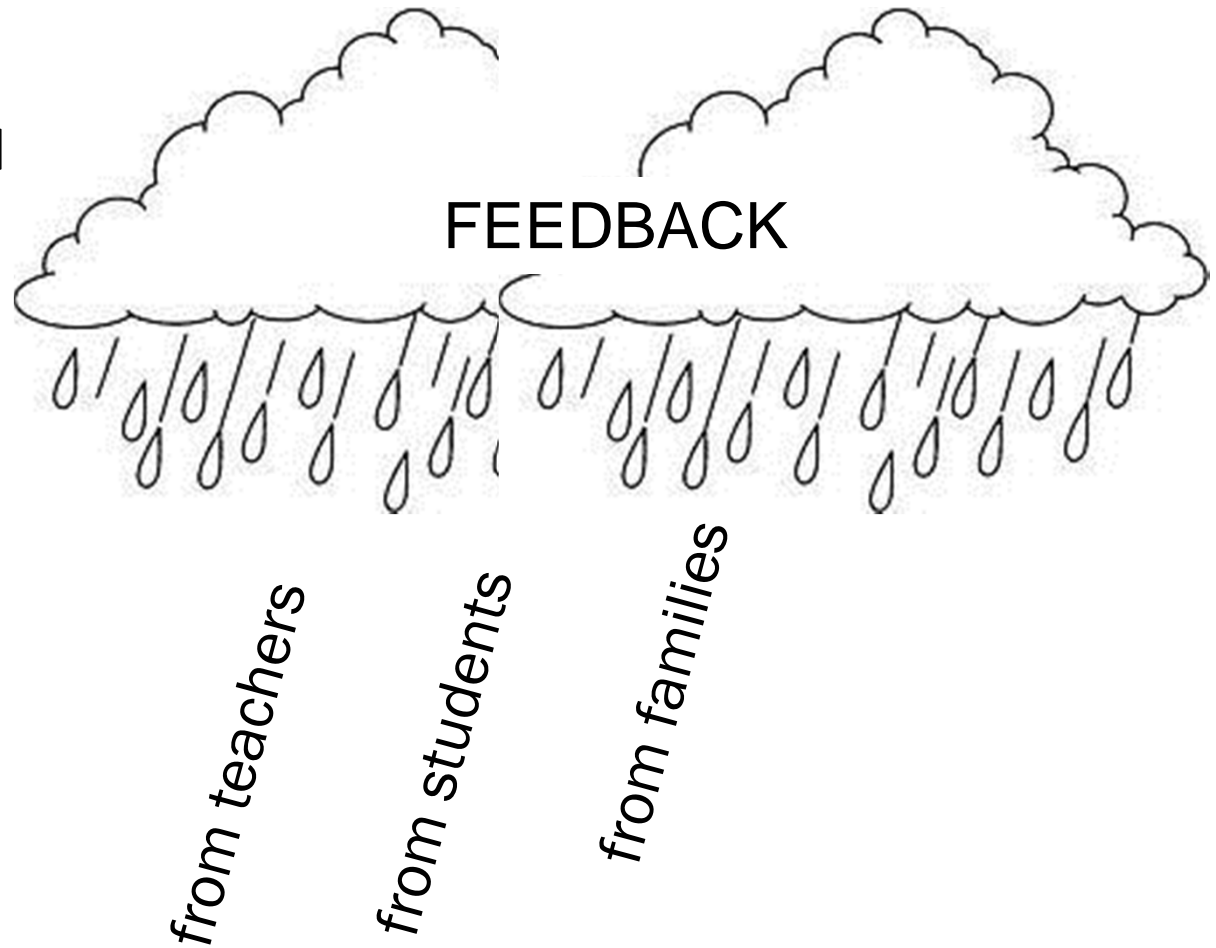


# THE CORE TEAM



METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)

## THE 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.




METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)

## **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.



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MIDDLE SCHOOL SCIENCE  
(EVALUATION)



## 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.*

JUNE 14, 2012

- 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...*



METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)

## 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.”*



METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
(EVALUATION)

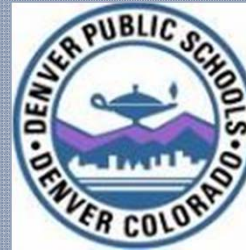


# EFFICACY STUDY IN ONE FORMAL-INFORMAL PARTNERSHIP: WHAT WE ARE MEASURING

JUNE 14, 2012



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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

THE METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
EFFICACY STUDY

# DATA COLLECTION EFFORTS



Standardized  
Student  
Science  
Assessment

Pre and Post in 7<sup>th</sup> 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 8<sup>th</sup> Grade Standardized Scores  
in Intervention and Control Schools/Students

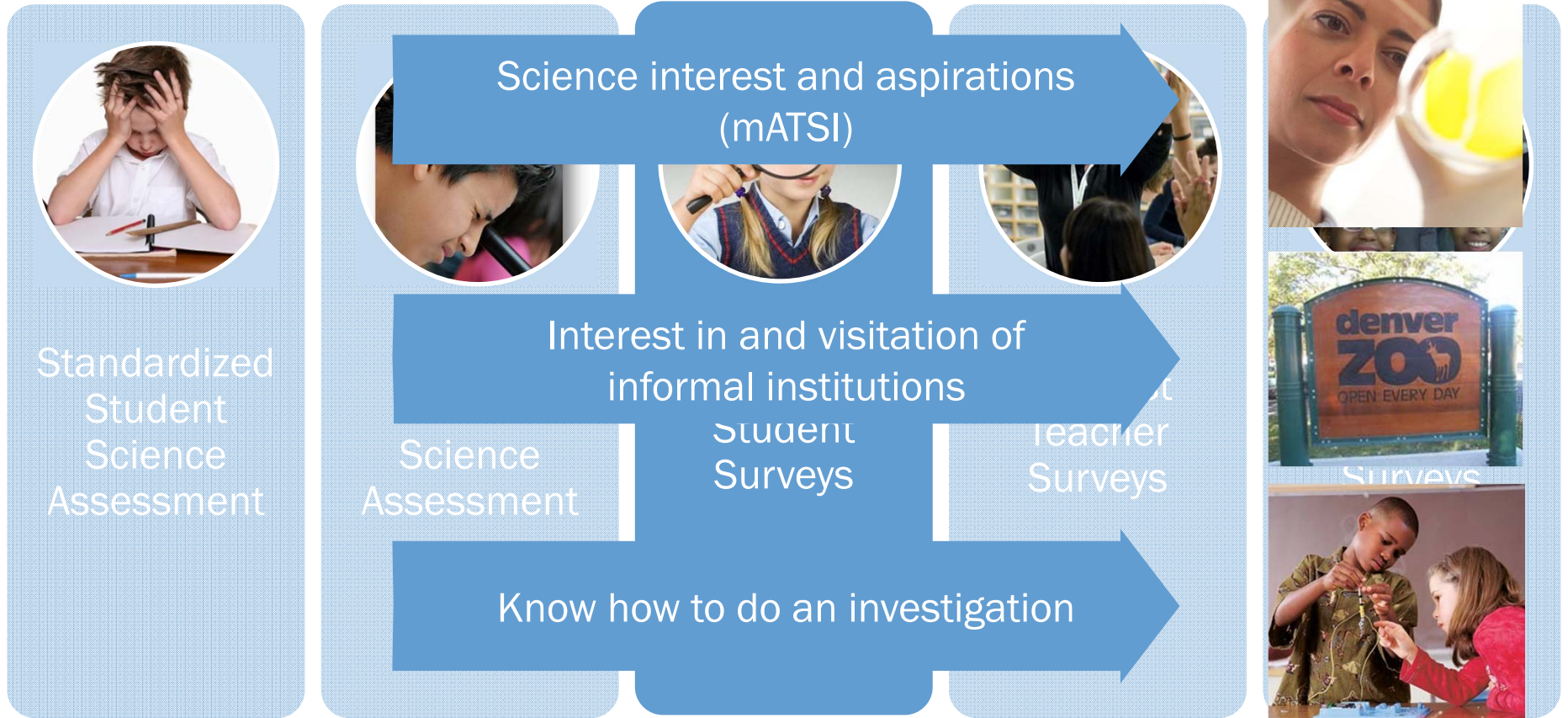


Post-only  
Parent  
Surveys

THE METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
EFFICACY STUDY



# DATA COLLECTION EFFORTS



THE METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
EFFICACY STUDY



# DATA COLLECTION EFFORTS



Standardized  
Student



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

Pre-Post  
Student

Pre-Post

Pre-Post

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

Use of Field Trip Templates and Materials



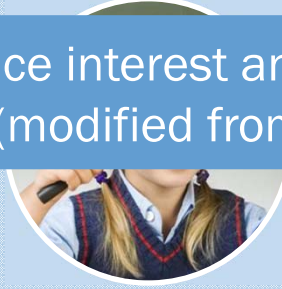
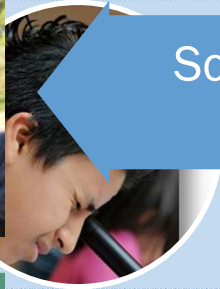
Post-only  
Parent  
Surveys

THE METRO DENVER URBAN ADVANTAGE  
MIDDLE SCHOOL SCIENCE  
EFFICACY STUDY

# DATA COLLECTION EFFORTS



Science interest and aspirations  
(modified from mATSI)



Post-only  
Parent  
Surveys



Self-efficacy for helping student  
with science homework

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Assessment

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stud  
Science  
Assessment

Student  
Surveys

Teacher  
Surveys



Interest in and visitation of  
informal institutions

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







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

# Guiding Questions

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- 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

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

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



New York City Council







## 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: <ul style="list-style-type: none"><li>• Introduce four types of scientific investigations</li><li>• Learn about cultural institutions and UA resources</li></ul>	Inquiry workshops to: <ul style="list-style-type: none"><li>• Conduct an in-depth examination of two types of scientific investigations</li><li>• Complete a science exit project</li><li>• Increase teachers' repertoire of field trip destinations</li></ul>	Inquiry workshops to: <ul style="list-style-type: none"><li>• Expand teachers' repertoires about scientific investigations and cultural institutions</li><li>• Refine classroom practices and examine student work</li><li>• Address difficult inquiry areas (e.g., constructing scientific explanations)</li></ul>

# 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...](#)



Cary Institute  
of Ecosystem Studies

*The science behind environmental solutions*

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## HUDSON RIVER ECOSYSTEM STUDY



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[Photo Gallery](#)

[Data](#)

[Publications](#)

[Links](#)

### *Changing Hudson Project Unveiled*

The Hudson River is one of New York State's treasures. Our country's history is intimately tied to the River; Revolutionary War battles, artistic movements, innovations in shipbuilding, and the first industrial revolution have all taken place on its shorelines. Over the past century, human use has negatively impacted the river's environmental status. Understanding its ecology is imperative to protect the functionality and beauty of the river for generations to come.

Since the mid-1980's, Institute scientists have been researching the Hudson River ecosystem—from the way shoreline development impacts water quality to how the spread of invasive species affects aquatic life. As a result of Institute research, the Hudson River is one of the most scientifically scrutinized rivers in the world. With nearly one hundred papers published in scientific journals, as well as popular magazine, radio, and television coverage, Institute research helps inform sound river management strategies.

By treating the Hudson River estuary as an integrated system, as a research site that spans from Troy, NY, to the Tappan Zee Bridge, Institute research analyzes the river within its

- 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

**RIVER ECOLOGY**  
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[Home](#)  
[Explore the River](#)  
[Meet the Scientists](#)  
[Graph the Data](#)  
[Analyze the Data](#)

## Meet the Scientists



00:25 02:09

These video segments and text passages with discussion questions (listed below) provide a case study of the Cary Institute scientists at work on the river and in their labs. You can watch the video segments and read the passages to help answer the discussion questions. There is also a 7-minute video documentary feature of the Cary Institute scientists' work.

<b>Part 1: The Problem</b>	(2:02)	<a href="#">[download]</a>
Passage One: An Unwelcome Newcomer ( <a href="#">Teacher</a>   <a href="#">Student</a> )		
<b>Part 2: Observation</b>	(3:29)	<a href="#">[download]</a>
Passage Two: Zebra Mussels and the Hudson River ( <a href="#">Teacher</a>   <a href="#">Student</a> )		
<b>Part 3: Results</b>	(4:16)	<a href="#">[download]</a>
Passage Three: The Short-Term Impact of the Zebra Mussel Invasion ( <a href="#">Teacher</a>   <a href="#">Student</a> )		
<b>Part 4: Going Further</b>	(2:55)	<a href="#">[download]</a>
Passage Four: Long-Term Monitoring of the Hudson River ( <a href="#">Teacher</a>   <a href="#">Student</a> )		
<b>Documentary Feature</b>	(7:39)	<a href="#">[download]</a>



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## 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.....?



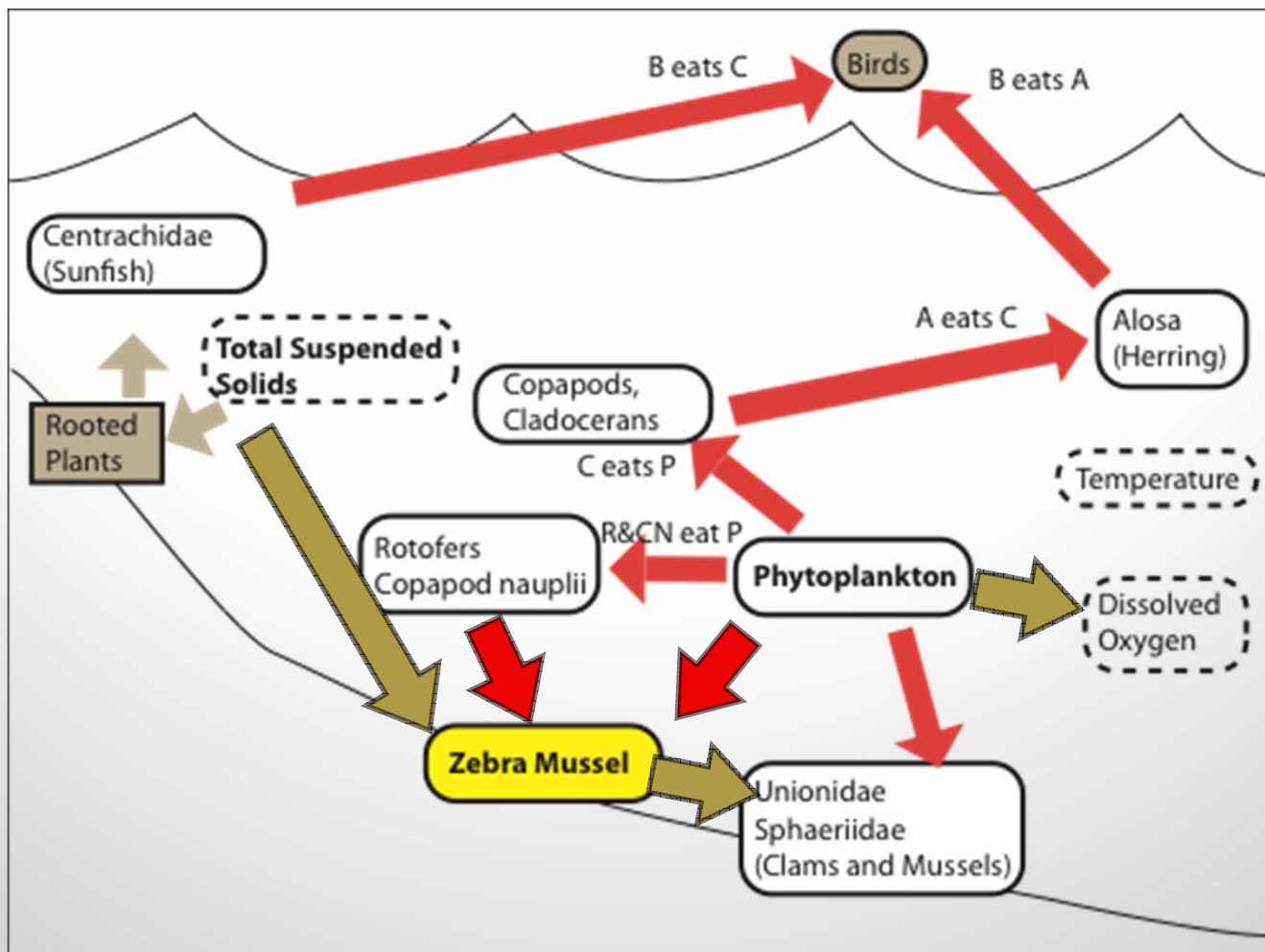
# Out in the Field

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# Building an Investigation

- How will \_\_\_\_\_ affect \_\_\_\_\_?





# RIVER ECOLOGY

Investigating the effect of  
zebra mussels on the  
Hudson River

- Home
- Explore the River
- Meet the Scientists
- Graph the Data

- Overview

- Over Time

- Along the River

Analyze the Data



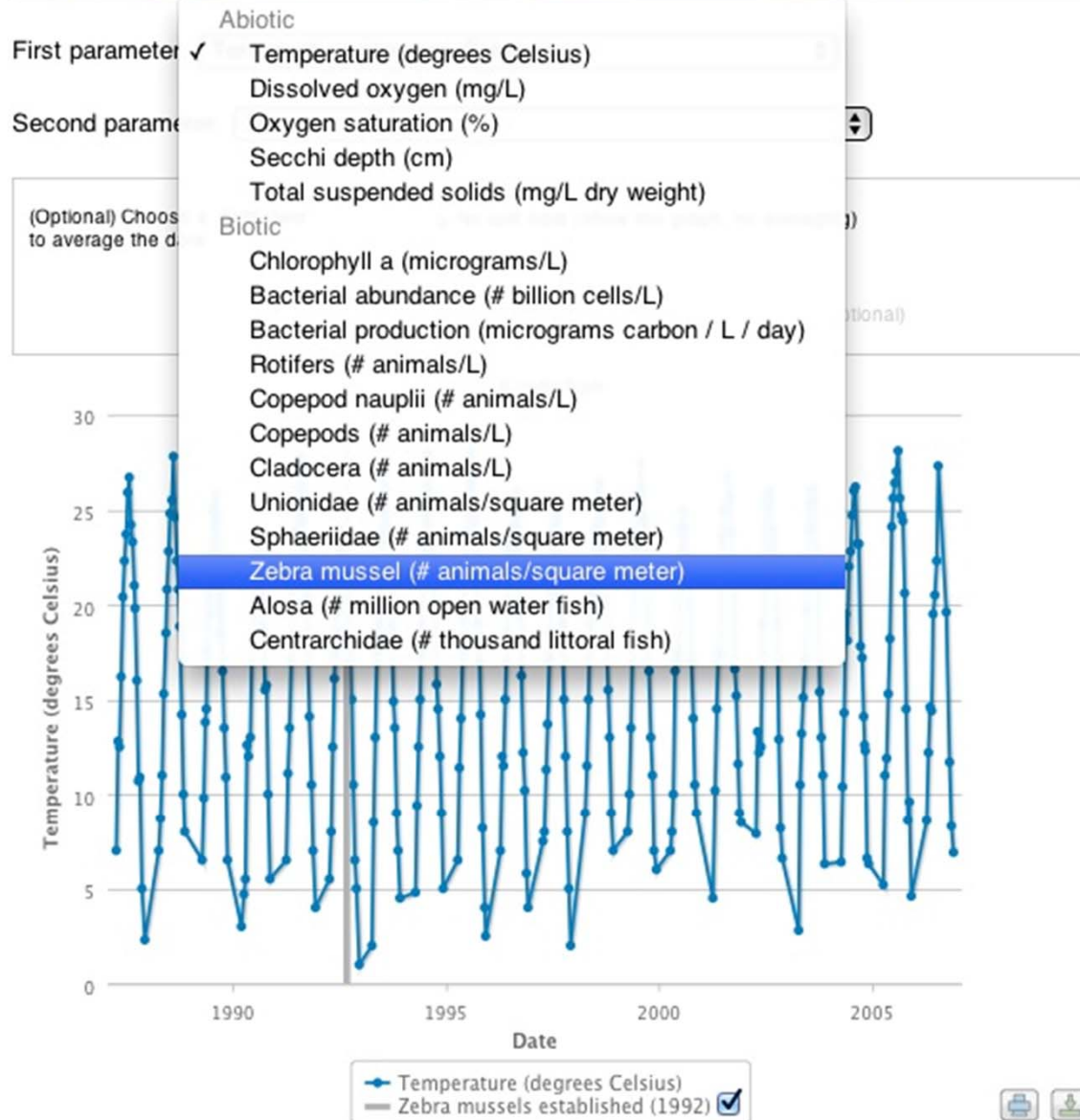
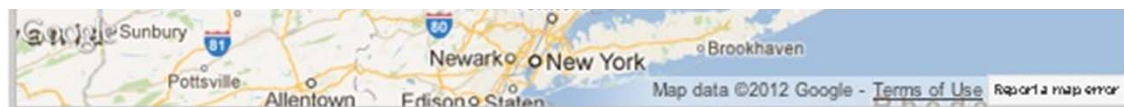
Graph the Data:

## Over Time

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







Show/Hide the date marker using the checkbox  
Drag within chart to zoom

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

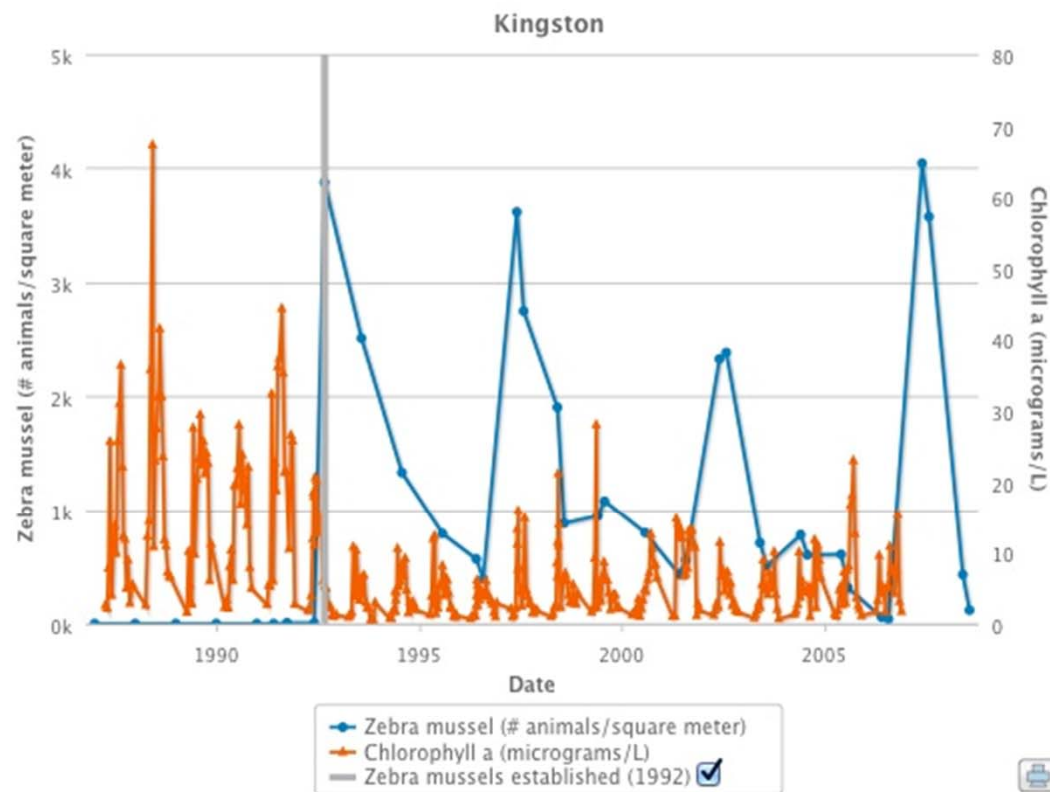
Second parameter: Chlorophyll a (micrograms/L)

(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)

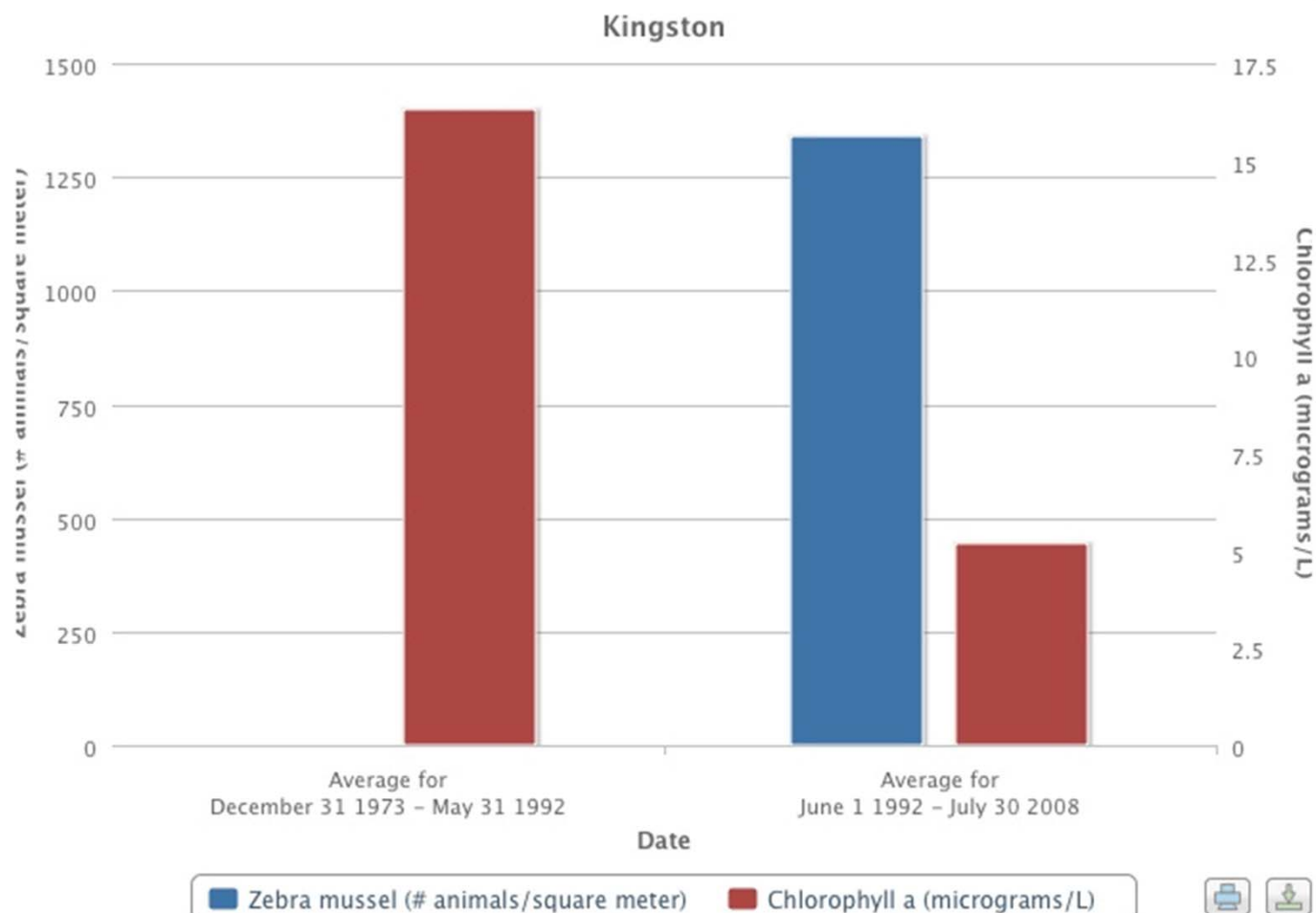
Second parameter: Chlorophyll a (micrograms/L)

(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)

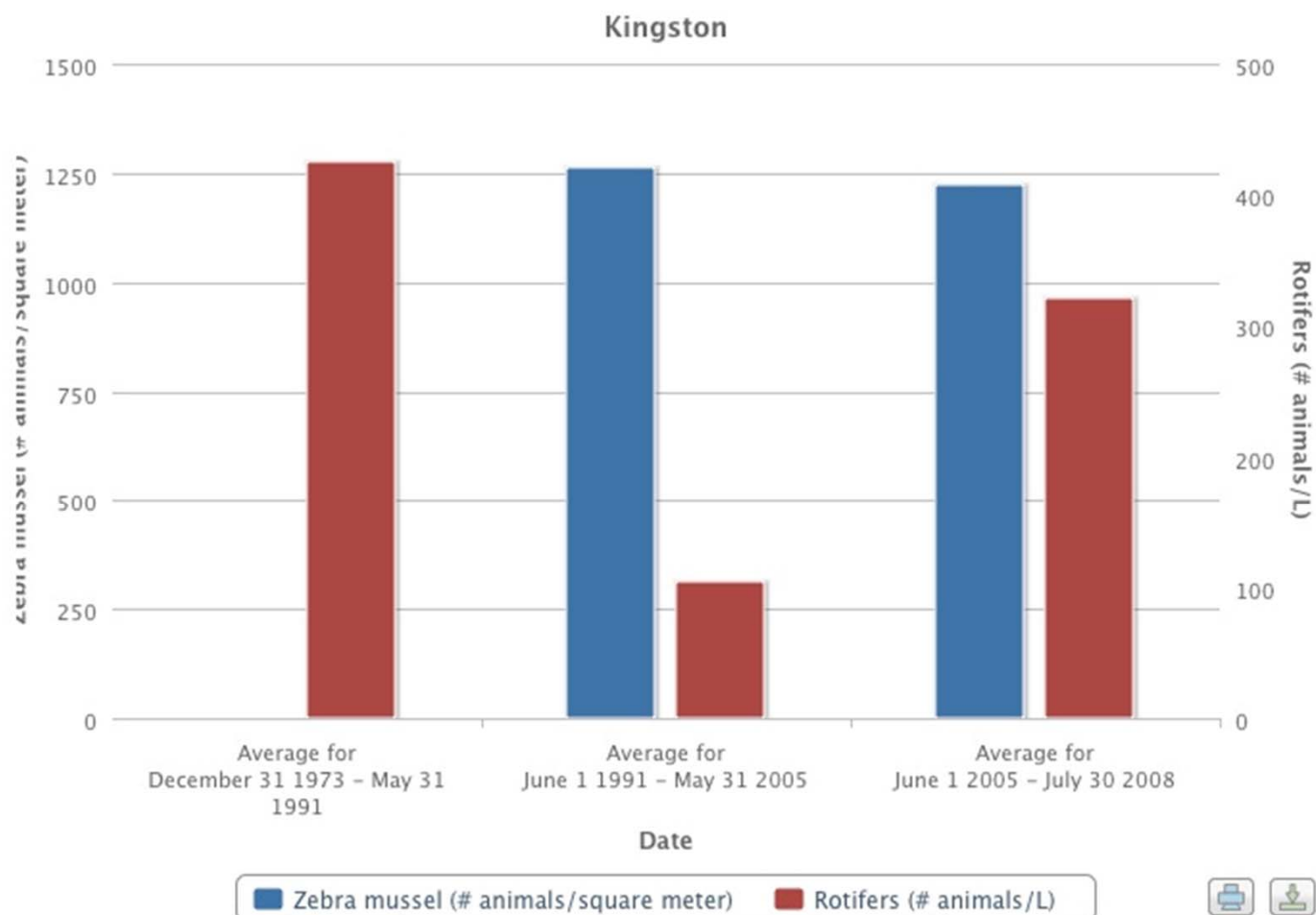
Second parameter: Rotifers (# animals/L)

(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)





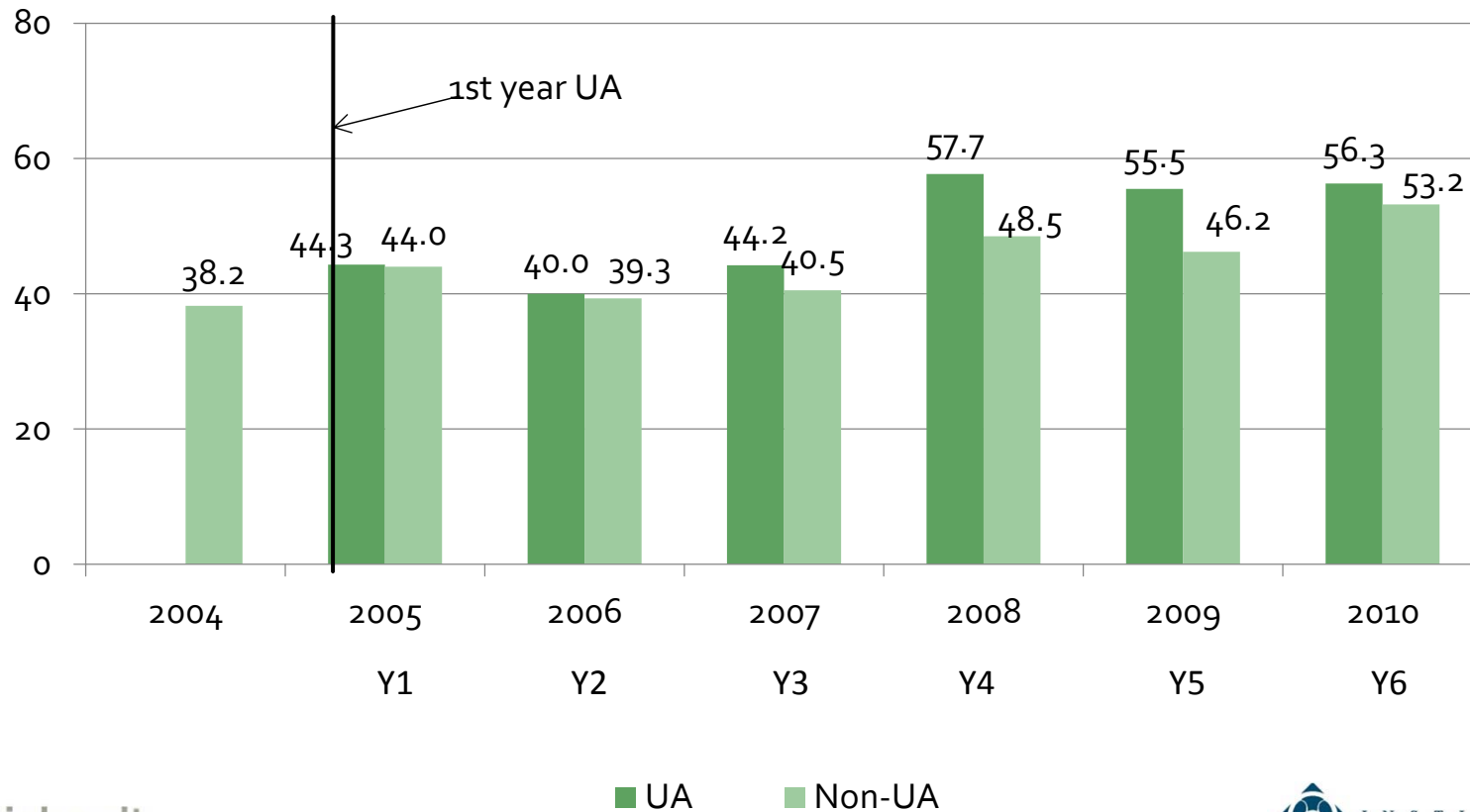
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## **River Ecology Teaching Case**

[amnh.org/education/hudsonriver](http://amnh.org/education/hudsonriver)

# Raw performance data suggests UA is effective

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





# Teaching Teachers Science: The Case of Urban Advantage

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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

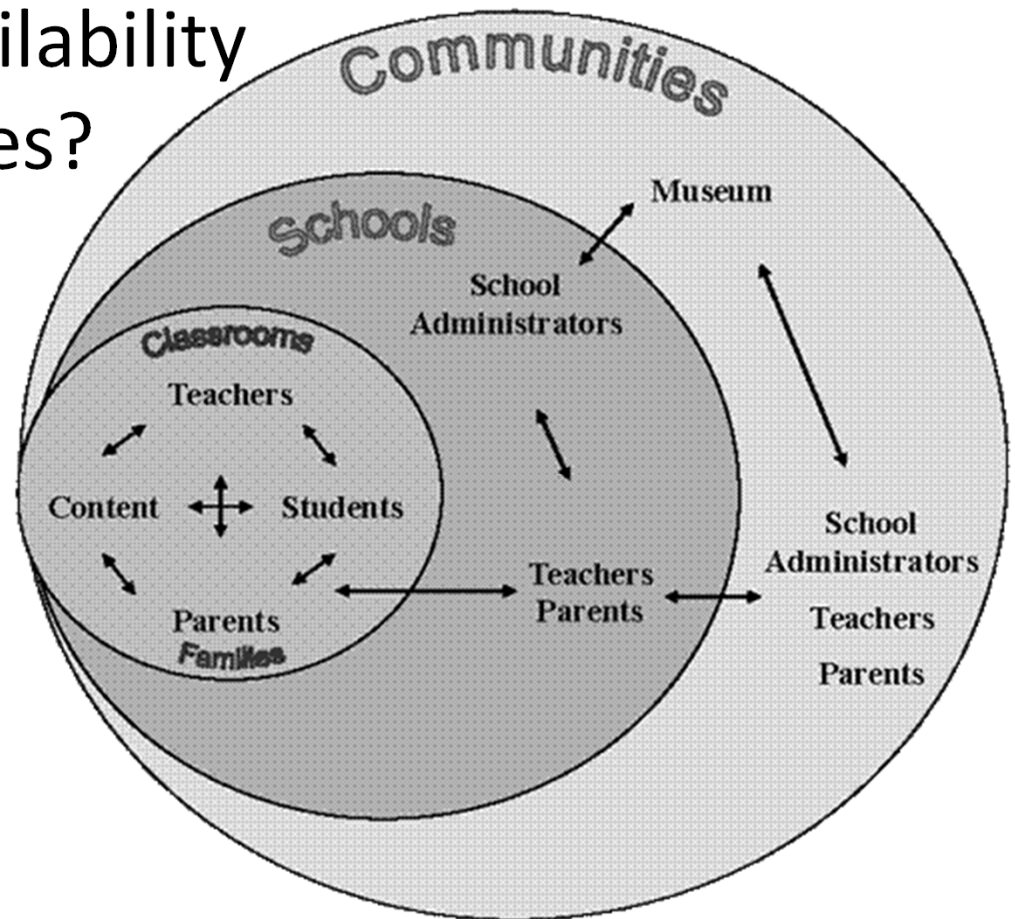


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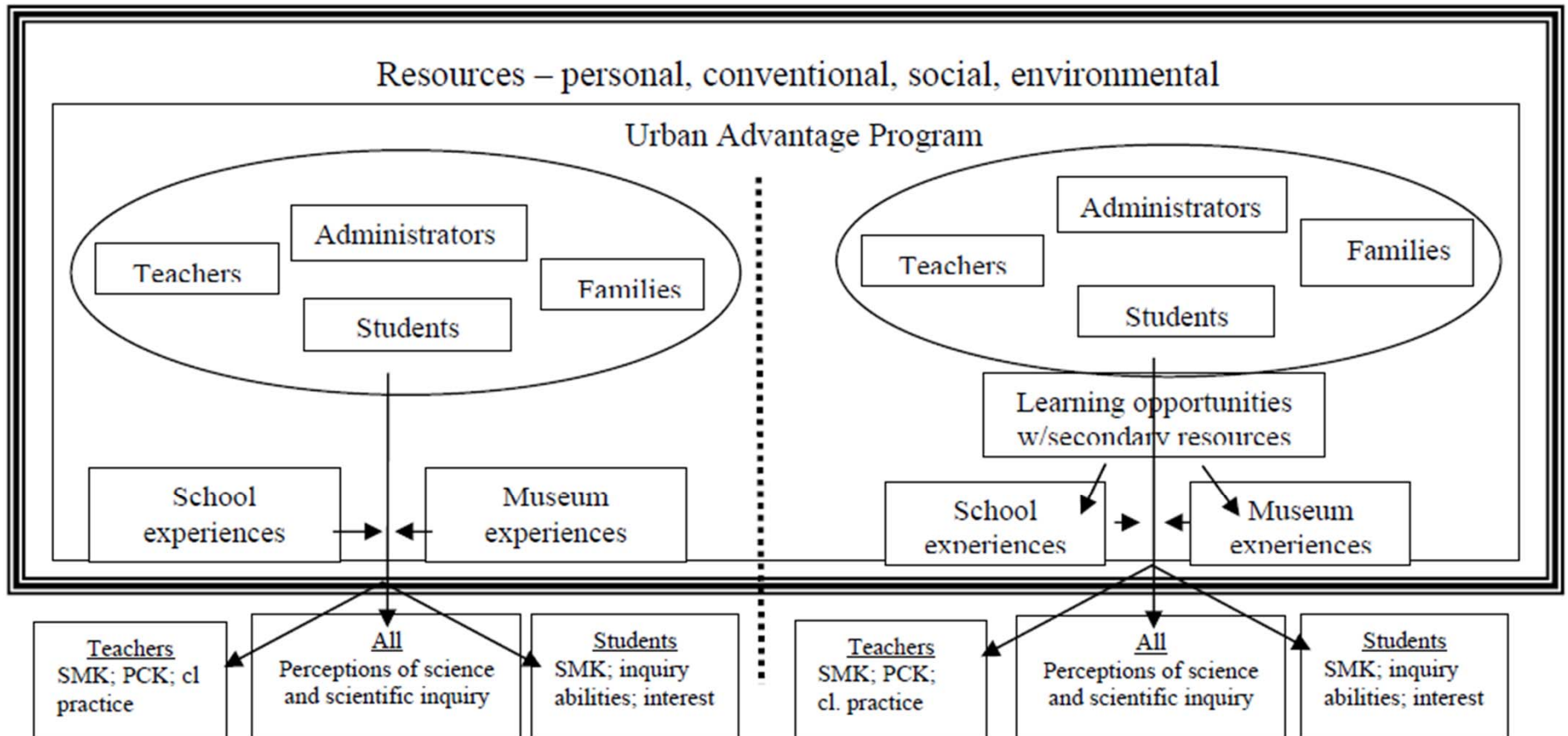
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# Research Project

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



# Research Design





# Methods

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- 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

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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

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## 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





# Findings: Teachers' PD Learning Opportunities

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- 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”



# Findings: Teachers' Learning

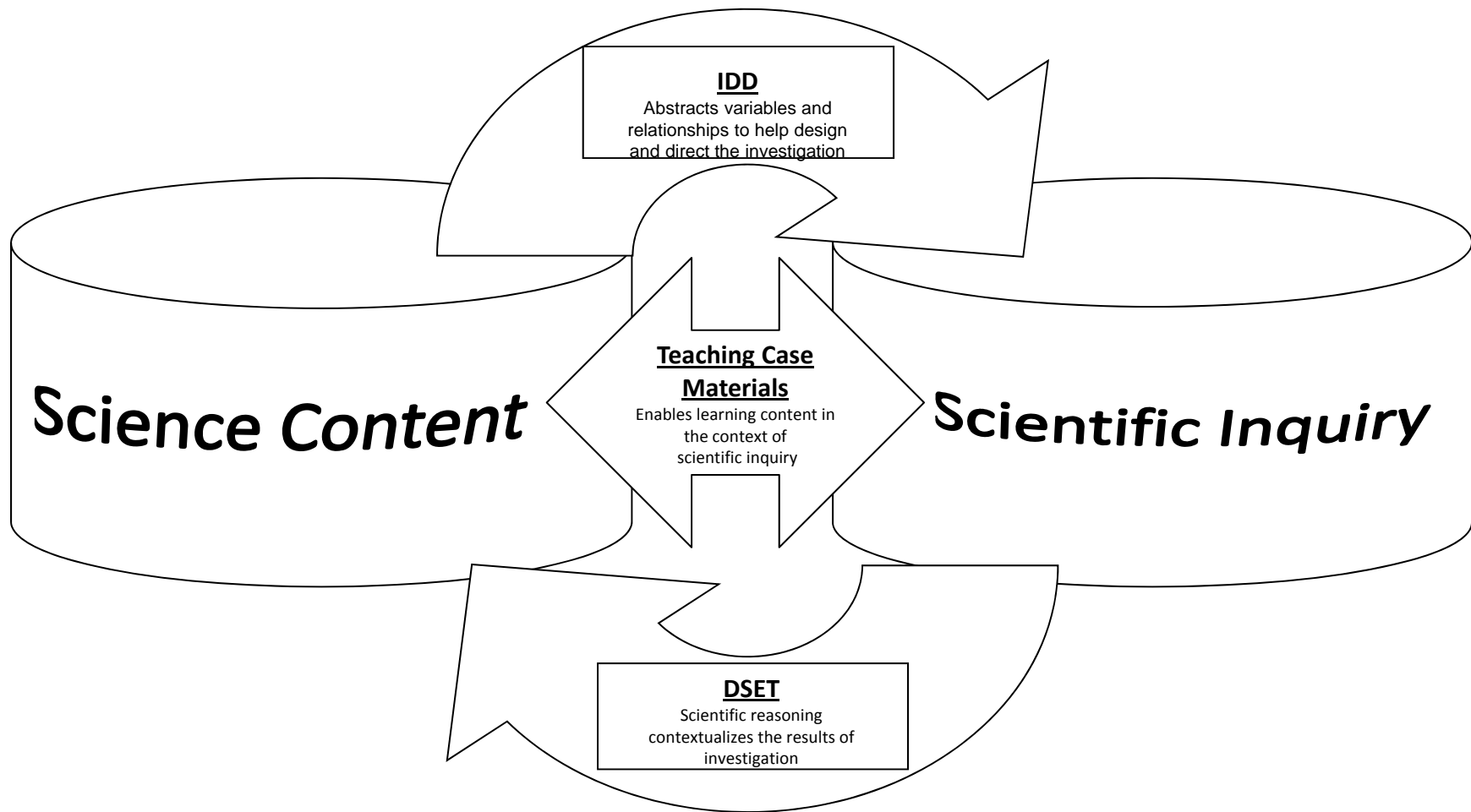
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- Quality of exit projects varies considerably *across* projects but remains largely consistent *within* projects
- Immediate appropriation of tools and language into practice
- Teachers use UA resources to support their attempts to teach inquiry: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



# Interplay between Science Content and Scientific Inquiry

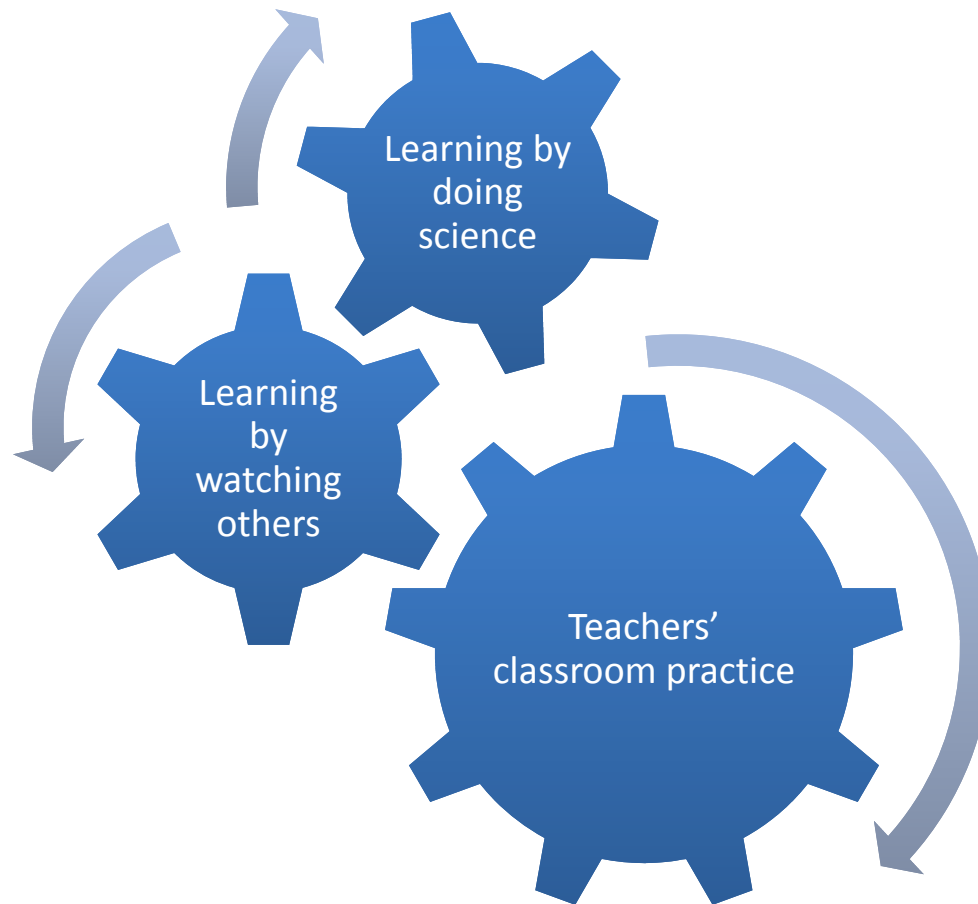
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# Theory of Teacher Learning and Change

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# Continued Work

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- 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

- *Thinking about accountability and outcomes.*
- 
- *Effects of studying something.*
- 
- *How formal/informal partnerships need to have an “it” to focus their joint work.*