

An aerial photograph of the Hudson River. In the center, a large concrete dam with a curved spillway spans the river. To the left of the dam, there are several large, rectangular basins, likely for water treatment or storage. The river flows from the top left towards the bottom right. The surrounding landscape includes green forested hills in the background and urban areas with buildings and roads in the foreground and middle ground. The sky is clear and blue.

An Interdisciplinary Analysis of  
**The Hudson River  
Watershed**

**SUNY-ESF**  
**Environmental Science Educational Unit**

**ESF Educational Outreach**  
Syracuse, New York



# An Interdisciplinary Analysis of the Hudson River Watershed

Supplemental Curriculum Materials for  
Secondary Teachers and Students in Science, Social Studies, English, Art  
and Technology

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SUNY College of Environmental Science and Forestry  
ESF Educational Outreach

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Dear Colleague:

The State University of New York College of Environmental Science and Forestry's specialized mission focuses on environmental science, design, policy, management, and engineering. ESF has 8 academic departments (Chemistry, Construction Management and Wood Products Engineering, Environmental and Forest Biology, Environmental Resources and Forest Engineering, Environmental Studies, Forest and Natural Resources Management, Landscape Architecture, and Paper Science Engineering). With its main campus in Syracuse, New York, ESF's regional instructional and research campuses are distributed across 25,000 acres in central and northern New York State, ranging from the Appalachian Mountains and Great Lakes basin to the St. Lawrence River and the Adirondack Highlands. ESF is one of the 8 doctoral granting research institutions of SUNY and its sponsored research funding awarded per faculty member at ESF is the highest of all SUNY units (excluding the health science centers). Graduate students comprise approximately one-third of ESF's student body (1,800).

ESF has a ninety-year history in educational outreach to the community. Collectively, ESF faculty and staff members contribute more than 6,500 hours annually in service to New York schools and school teachers, community groups, non-profit organizations, and government and other agencies. ESF's Office of Educational Outreach and Educational Outreach Council coordinates numerous innovative programs community outreach programs ([www.esf.edu/eo/](http://www.esf.edu/eo/)). ESF's significant contributions to secondary education are derived from its strength as a major research institution in the natural and social sciences and its high academic rigor. The development of a series of new **Environmental Science Educational Units** is an initial step in expanding our educational outreach to the community by making ESF's vast resources available to partnering high schools and students.

SUNY ESF **Environmental Science Educational Units** will fulfill an expressed need of New York State high school educators resulting from the newly implemented New York State Department of Education high school standards for math, science, and technology (MST), social studies, and English. The new standards stress the essential roles of problem solving, critical thinking skills, and hands on experiences for high school teaching and learning. Moreover, the new standards promote the use of inquiry-based learning techniques and student research that promote in-depth understanding of both content and the process of self-directed inquiry. In fact, the use of "inquiry approaches" is acknowledged as one of the five guiding principles of best practice in Mathematics, Science, and Technology. The new SUNY ESF **Environmental Science Educational Units** were specifically designed to enable teachers to cover the new state standards in MST, Social studies, and English using interesting and engaging topics in the Environmental Sciences. ESF faculty and staff worked in cooperation with a team of New York State Teachers to ensure the utility of each lesson in the high school classroom environment.

Sincerely,

Rick Beal, Ph.D. SUNY ESF Educational Outreach Associate



# An Interdisciplinary Analysis of the Hudson River Watershed

## Instructors' Overview

*An Interdisciplinary Analysis of the Hudson River Watershed* educational unit is a series of lessons designed to cover specific New York Department of Education learning standards, using interesting and interactive student-centered activities that enhance student participation and understanding. The interdisciplinary nature of the unit facilitates team teaching and collaborative learning between classes as diverse as Math, Science and Technology, Social Studies, English, Art. The educational unit's main focus is on the Hudson River Watershed, but the lessons learned in this unit can also be applied to environmental challenges found in other areas of the United States and the world.

## History of the Hudson River

The Hudson River is not the longest, widest, or deepest river in the United States. Still, it is one of the country's most famous rivers, known for its value as a vital resource and as the centerpiece of the country's largest metropolitan area. In addition, the Hudson River is highly regarded for its breathtaking beauty.

Ever since humans first settled in the Hudson Valley, the river has been subject to a variety of uses, such as a source of food, a means of transportation, a place to dispose waste, and as the focal point of a painter's canvass. To this day, the Hudson has dazzled people with its many faces, whether it is a mountain cascade, a bottomland for dairy farms, a watery zone for factories, or a teeming stretch of commerce for dozens of ships in the midst of New York City.

For years, the Hudson River has been able to meet the needs of a growing population with little thought given to the long-range impact on the quality of the river. Only recently has the Hudson River been viewed as finite resource, with every new human alteration measured carefully in relation to the well being of the river. Due to the growing awareness of the fragility of the river, enormous amounts of money and time have been spent to bring the river back to the kind of health it enjoyed before the arrival of Europeans to the region. This does not mean that the river is no longer threatened and has reached a static point in its history, in which the river is no longer subject to the kinds of pressures that could have long-term and devastating consequences. On the contrary, the river is still subject to numerous proposals that could alter significantly the character and health of the body of water. The Hudson River Educational Unit asks the teachers and students to analyze some of the important scenarios that face the river.

## Hudson River Education

The Hudson River Watershed educational unit allows the educator to provide students with activities that encourage them to think critically about the various ways in which humans have made use of the Hudson (and most other rivers in populated areas, for that matter), and how human use has impacted the water quality of the Hudson River. These activities give students



the chance to weigh the benefits of economic growth with those of preservation. Questions include: Is there a way in which the largest urban population in the country can continue to foster the many economic benefits of the river, without causing substantial damage to the water and its environs? Can the Hudson exist simultaneously as an industrial and urban valley, as well as a natural and scenic corridor? Just how much human development can the river sustain? What kinds of unique pressures is the Hudson likely to face in this new century?

What follows is a series of lessons that address some of the ways in which the Hudson has been used and may perhaps be used in the future. For many of these topics, there are at least two sides to the story and your students will be encouraged to measure the costs and benefits of each argument. While the general thrust of these lessons is social in scope, each also draws upon the biophysical sciences (Biology, Chemistry, Earth Science, and Physics) and other quantitative disciplines.

## **Series of Lessons**

### **Lesson 1 - A Historical Perspective of the Hudson: Change Through Time**

This lesson introduces students to the extensive and diverse interaction humans have had on the river. Students are presented with a series of maps (and later photos) of a certain stretch of the river, representing different time periods. By examining the different maps, the students will be able to see what was important to the mapmaker, and how he or she viewed the river. Students should also be able to identify transitions of use with changes in population over time. Available teaching resources include various maps of the Hudson in the Bronx / Westchester region. This region of the Hudson developed from a largely agrarian corridor with small villages to a largely urban / suburban region with an industrial focus. Lesson 1 will be an excellent vehicle to enhance the map reading skills of students, as well as their ability to extract and interpret data from maps.

### **Lesson 2 - The Hudson School Painters: Attitudes of Nature as a Reflection of Art**

This lesson asks students to examine aesthetic themes of the Hudson River painters, and to weigh their visions of how humans might relate to the landscape with the current attitudes held by preservationists and conservationists. Students are split into groups and are provided with various scenes of the Hudson as portrayed by famous Hudson River painters. Students first have to select their favorite scene and then dissect why the scene was chosen, identifying what appeals to them in that landscape. This exercise should get students to examine and think about differences between the favored tamed landscapes or the exaggerated wild scenes devoid of human imprint. Lesson 2 also encourages students to think about looking at nature from preservationist vs. conservationist, and macroscopic, vs. microscopic viewpoints.

### **Lesson 3 - Watershed Boundaries - Mapping Land Use and Impact in a Watershed**

This lesson allows students to examine topographic maps in order to delineate a local watershed, located in the Hudson River Watershed. By analyzing the boundaries of a local watershed, students will begin to understand the interconnectedness of watershed ecosystems. By identifying the watershed boundaries of a tributary feeding into the Hudson River, students



will be able to examine the scale of their watershed in comparison to the much larger Hudson watershed. With the watershed delineated, students can investigate land uses and learn how such factors influence not only the water in their own geographic region, but also the connecting downstream systems all the way to the Hudson Harbor.

#### **Lesson 4 - Tidal Flow on the Hudson-Ecological Impact**

This lesson emphasizes the unique ecology of the Hudson River and its tides, focusing on the inland tides and how they affect the water and habitats found along the Hudson River. The connection of tides to habitats and to organisms is examined in this lesson, and the importance of the quality and preservation to these relationships is accentuated. Students will keep a record of high and low tides on the Hudson River as related to their community and will discover the effects of these tides on the local habitats and the organisms that depend on them.

#### **Lesson 5 - Estuarine Habitats-Between Fresh and Salt Water**

Estuaries are significant to the survival of many aquatic and terrestrial species. Lesson 5 focuses on the ecology of the Hudson River estuaries and wetlands. It examines inland tides and questions how they affect the water and habitats found along the Hudson River. The connection between tides, habitats and organisms is examined in this lesson and the importance of the quality and preservation to these relationships is emphasized.

#### **Lesson 6 - Potential Sources of Pollution in the Hudson Basin**

The environmental interaction of humans, to tides, to habitats, to organisms is examined in this lesson, and the importance of quality and preservation of these relationships is accentuated. “Think globally and act locally” is the philosophy we should consider when we make choices affecting the estuaries, as well as other important waterways.

#### **Lesson 7 - Current Environmental Issues of the Hudson River**

This lesson encourages students to look at a current issue concerning the Hudson River. The issue of PCB pollution and pollution remediation has been selected as a key example because of its current relevance. Students are instructed to do research using the Internet to find information, and then write a position paper reflecting their thoughts on the given situation. Students gain an understanding of basic organic chemistry and the processes of bioaccumulation and bio-magnification. Although PCB pollution is an important pollutant in the Hudson River Basin, this lesson allows students to research other important pollutants as well.

#### **Lesson 8 - Sewage Treatment on the Hudson - Impacts on a Local Community**

One of the greatest pressures on the river is that of human waste disposal. Dozens of sewage treatment plants are situated along the Hudson River. The effect of this is two-fold: first, the quality of the river is altered and potentially degraded, and second, the community in close proximity of this facility has to deal with airborne emissions as a result of sewage processing. Lesson 8 involves a close examination of one particular facility that was constructed in the 1980’s as a state-of-the-art complex: the North River Sewage Treatment Plant. Not only was the most modern technology utilized in this plant, every effort was made to make it palatable to the

adjacent community of West Harlem. For example, a state park was built on top of the plant to serve the recreational needs of nearby residents. A close look at issues surrounding the plant reveals there are no perfect solutions when it comes to the matter of sewage. Furthermore, there are to this day negative outcomes in relation to the air and water quality as well as the satisfaction of local residents.

This lesson provides students with the opportunity to evaluate a body of data and reports, and to make an assessment regarding the placement and development of this “proposed” facility. Lesson 8 will then give students the chance to role play and set up a town hall meeting to negotiate a final decision regarding a sewage treatment plant, and to evaluate whether there are more appropriate alternatives.

### **Lesson 9 - The Fate of the Hudson Sturgeon – A Historical and Ecological Study**

The size, health, and extent of fish populations are barometers of water quality in the Hudson. One fish that has long been a mainstay of the Hudson is the legendary Atlantic sturgeon, a giant fish prized for its smoked flesh and caviar. Lately, populations of this fish have been in decline.

What is responsible for the decline of this fish? A series of documents with opposing views are provided for students. The student has to evaluate the data, sift through the documents, and arrive at some kind of conclusion regarding the status of this fish, and the cause(s) of its demise in the river. This lesson also gives students the opportunity to develop a management plan for the fate of the sturgeon. By looking at these opposing views on this issue, students are faced with balancing conservation and economic aspects for the Atlantic sturgeon. Students also have the opportunity to graph, analyze, and interpret original scientific data.

### **Lesson 10 - The Future of the Hudson River – Proposals for Development**

This last lesson allows students to examine future scenarios for the Hudson River and its valley. As we begin to transition from an industrial to a more service-oriented economy, and as we begin to understand better the fragile ecological balance of the Hudson, the future of the river is far from certain.

With this lesson, students will examine two controversial proposals now being considered for the Hudson River Region: first, the construction of a mammoth power plant in Athens, and second, a Greenway to link New York City with Troy. Lesson 10 sets up a series of exercises that encourage inquiry and thoughtful analysis of the issues at stake. Students will conduct Internet research, create a journalistic piece, and finally, debate one of the two issues.



**Correlating the Hudson River Watershed educational unit to the New York State Learning Standards for MST, Social Studies and English at the Commencement level**

	L e s s o n s									
MST Standards	1	2	3	4	5	6	7	8	9	10
<b>MST Standard 1 Analysis, inquiry, and Design</b>	1	2	3	4	5	6	7	8	9	10
<b>Mathematical Analysis</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1			*				*			
Key Idea 2			*					*	*	
Key Idea 3			*			*	*			
<b>Scientific Inquiry</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1	*		*	*		*	*			
Key idea 2	*		*			*				
Key idea 3	*		*	*		*		*		
<b>Engineering Design</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1							*			
<b>MST Standard 2 Information Systems</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1	*	*	*	*			*	*		*
Key idea 2				*	*	*				
Key idea 3										
<b>Standard 3 Mathematics</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1			*	*		*	*		*	
Key idea 2				*		*				
Key idea 3							*			
Key idea 4			*	*		*	*		*	
Key idea 5			*	*		*				
Key idea 6							*			
Key idea 7			*	*		*			*	
<b>Standard 4 Physical Setting</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1				*	*					
Key idea 2				*	*	*				
Key idea 3						*				
Key idea 4						*				
Key idea 5				*						



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<b>Standard 4 Living Environment</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1	*		*							
Key idea 2					*					
Key idea 3									*	
Key idea 4									*	
Key idea 5					*				*	
Key idea 6	*		*		*				*	*
Key idea 7	*		*						*	*
<b>Standard 5 Technology</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1			*		*	*	*			
Key idea 2			*							
Key idea 3					*		*	*		
Key idea 4			*							
Key idea 5	*									
Key idea 6						*	*			
Key idea 7							*			
<b>Standard 6- Interconnected- ness: Common themes</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1		*	*		*	*		*		
Key idea 2	*	*	*	*	*	*	*	*		
Key idea 3			*					*	*	
Key idea 4			*	*	*	*		*	*	
Key idea 5	*		*	*	*		*	*	*	*
Key idea 6			*				*	*	*	*
<b>Standard 7- Interdisciplinary Problem Solving</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1	*	*	*	*	*	*	*	*	*	
Key idea 2	*	*	*	*	*	*	*	*	*	
<b>Skills and Strategies for Interdisciplinary Problem Solving</b>	1	2	3	4	5	6	7	8	9	10
Working Effectively	*	*	*	*	*	*	*	*	*	
Gathering and Processing Information	*	*	*	*	*	*	*	*	*	
Generating and Analyzing Ideas	*	*	*	*	*	*	*	*	*	
Common Themes	*	*	*	*	*	*	*	*	*	
Realizing Ideas	*	*	*	*	*	*	*	*	*	
Presenting Results	*	*	*	*	*	*	*	*	*	

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Learning Standards for Social Studies	1	2	3	4	5	6	7	8	9	10
<b>Standard 1 History of U.S. and New York State</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1	*	*						*	*	
Key idea 2		*						*	*	
Key idea 3	*	*	*							
Key idea 4	*	*								
Key idea 5			*							
<b>Standard 2 World History</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1										
Key idea 2										
Key idea 3	*									
Key idea 4										
<b>Standard 3 Geography</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1	*	*		*	*					
Key idea 2				*	*					
<b>Standard 4 Economics</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1							*			
Key idea 2							*	*		
<b>Standard 5 Civics Citizenship and government</b>	1	2	3	4	5	6	7	8	9	10
Key idea 1				*				*		
Key idea 2								*		
Key idea 3								*		
Key idea 4				*		*	*	*		



<b>Learning Standards For English</b>	1	2	3	4	5	6	7	8	9	10
<b>Standard 1 Information &amp; understanding</b>	1	2	3	4	5	6	7	8	9	10
<b>Key idea 1</b>	*		*	*	*	*	*	*	*	*
<b>Key idea 2</b>	*		*	*	*	*	*	*		*
<b>Standard 2 Literary response and expression</b>	1	2	3	4	5	6	7	8	9	10
<b>Key idea 1</b>	*							*	*	*
<b>Key idea 2</b>	*							*	*	*
<b>Standard 3 Critical analysis and evaluation</b>	1	2	3	4	5	6	7	8	9	10
<b>Key idea 1</b>	*		*	*	*	*	*	*	*	*
<b>Key idea 2</b>	*		*	*	*	*	*	*	*	*
<b>Standard 4 Social interaction</b>	1	2	3	4	5	6	7	8	9	10
<b>Key idea 1</b>	*			*	*	*	*	*	*	*
<b>Key idea 2</b>	*				*	*	*	*	*	*

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Learning Standards For The Arts	1	2	3	4	5	6	7	8	9	10
<b>Standard 1 Creating, Performing and Participating in the Arts</b>	1	2	3	4	5	6	7	8	9	10
<b>Idea 1 (Visual)</b>										
<b>Standard 2 Knowing and Using Arts Materials and Resources</b>	1	2	3	4	5	6	7	8	9	10
<b>Idea 2 (Visual)</b>										
<b>Standard 3 Responding to and Analyzing Works of Art</b>	1	2	3	4	5	6	7	8	9	10
<b>Idea 3 (Visual)</b>		*								
<b>Standard 4 Understanding the Cultural Dimensions and Contribution and Contributions of the Arts</b>	1	2	3	4	5	6	7	8	9	10
<b>Idea 4 (Visual)</b>	*	*								