TEACHERS COLLEGE
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THE BLACK ROCK FOREST CONSORTIUM: A NARRATIVE

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Submitted in partial fulfillment of the
Requirements for the Degree of Doctor of Education in Communications
Teachers College, Columbia University

2004

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INTRODUCTION

Our great outdoors is busier than the largest of cities and it is vital to appreciate and protect the many divergent creatures that fly, swim, scurry and leap through the flora and fauna of our forests, streams, and rivers culminating to create nature's symphony. Two hundred years ago, this country was a vast wilderness virtually unspoiled by man. Today our open spaces are deteriorating at an increasingly rapid rate, with the continuous loss of much of our forests, estuaries, prairies, and wildlife. The harm that is being perpetrated against the earth comes from human hands as we threaten all of the earth's innumerable species through deforestation, habitat destruction, pollution, and overpopulation.

People often fail to recognize the true threat of overpopulation and the startling extent to which humans continue to reproduce at an increasingly alarming rate, infringing on the success of the rest of the world's species.[1] Since 1960 the world's population has doubled. Currently, the human population continues to increase by 86 million persons a year. This number is analogous to another New York City every month or a new China every decade.[2] In 1800 there were one billion people living on the planet, but by 1930 that number had doubled to two billion. In October 1999, the World's population had

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[1] For more information on human population growth visit the Natural Resources Defense Council website at http://www.nrdc.org , Zero Population Growth at http://www.zpg.org, or World Bank Group http://www.worldbank.org.

[2] Natural Resources Defense Council. (1999). *Population and consumption at NRDC: Human population growth.* Retrieved June 1999, from http://www.nrdc.org

reached six billion, and according to projections based on the current rate of population growth, there will be twelve billion people living on the Earth by 2044.[3]

Overpopulation is having a detrimental impact on the Earth's ecosystems and wildlife causing deforestation, habitat destruction, endangered species, ozone depletion, air pollution, water pollution, and urban sprawl. With urban sprawl land is increasingly developed to provide housing, jobs, and shopping for suburban enclaves. [4] As urban areas have expanded in geographic size natural spaces are rapidly being replaced by homes, strip malls, office complexes, parking lots, and roadways.[5] In total we lose 7,000 acres of land a day across this country and currently have more shopping malls than high schools. [6] Urban sprawl has a detrimental effect on the environment by increasing pollution; threatening endangered species as it fragments or destroys habitat; and on quality of life as traffic increases, and open spaces disappear. [7]

In New York State, suburban boundaries continue to expand, worrying many individuals. Currently, a dramatic increase in development is occurring in an attempt to provide housing and increased commerce in the far-reaching outskirts of the New York City and Albany metropolitan areas. This has put a serious threat on the rapidly depleting open spaces in the Hudson Valley region [8]

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[3] Zero Population Growth. (1999). *Astonishing facts about population growth.* [Brochure]. Washington, DC: Zero Population Growth.
[4] Benfield, R., & Chen. (1991). *Once there were greenfields: How urban sprawl is undermining America's environment, economy, and social fabric.* (Published Report). New York, NY: NRDC and the Surface Transportation Policy Project.
[5] Purdham, T. (1999, February 6). Suburban sprawl takes its place on the political landscape. *New York Times.*
[6] Benfield, R., & Chen. (1991). *Once there were greenfields: How urban sprawl is undermining America's environment, economy, and social fabric.* (Published Report). New York, NY: NRDC and the Surface Transportation Policy Project.
[7] Whitman, C. (1998, December 15) Address to Partners for Smart Growth Conference. Austin, TX.
[8] Lieberman, B. *America the land of unsustainable growth.* Retrieved April, 1999, from http://www.sierraclub.org.

The importance of our open spaces is undisputed as they offer an escape to havens of beauty and splendor. Green spaces are priceless treasures offering our families a chance to appreciate the wonder of nature, protect ecosystems, come in contact with wildlife, learn about history, and enjoy numerous recreational activities. Whether these lands are forests, fields, hills, valleys, wetlands, beaches, deserts, lakes, rivers, or mountains they are all spectacular and invaluable in their own right. Protected lands contain numerous ecosystems that have almost disappeared from our suburban landscape.

As a result, the benefits of environmental conservation are almost immeasurable, including the need to protect our depleting open spaces from over-development and deforestation, the unlimited benefits of the recreational enjoyment of protected lands, wildlife conservation, and protection from habitat destruction, as well as scientific research and education. The long-term investigation of protected environments helps us understand the impact of humans on our ecosystems. Continued study and discovery will help us develop means to predict natural disasters, develop and implement alternative means for energy, discover new cures for diseases, and combat damage caused by excessive human infringement and industrial waste. .[9]

There is much we can learn from the great outdoors as they serve as a living textbook full of tangible real life examples and engaging activities. Natural spaces are crucial to the advancement of the study of science and wildlife as one examines the ecology, biochemistry, and animal species native to these lands. Natural spaces contain stories of ancient peoples and early pioneers, relics from artists, evidence from our

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[9] Natural Resources Defence Council. *Land at NRDC: Why we need public lands.* Retrieved June 1999, from http://www.nrdc.org.
Natural Resources Defence Council. (1995, June.) *Selling our heritage: Congressional plans for America's public lands.* Retrieved 1998, from http://www.nrdc.org.

ecological history, and accounts from historic battles. As a result, the protection of undeveloped lands helps to preserve human, and scientific history.

New York's Hudson River Valley has played a vital role in the history of our nation. It tells tales of Native Americans, Henry Hudson, the early Dutch settlers, the Revolutionary War, West Point, the Hudson River School of Art, and the estates of the Roosevelts, Vanderbilts, and Livingstons. Visiting this historic area can, will and does make history come alive.[10]

Recognizing the emergent need to protect and conserve our natural resources, the modern conservation movement formed and became a vital force in the late 1960's in New York's Hudson River Valley, beginning with the struggle to save a 3,750-acre forest known as the Black Rock Forest. Although it started as a relatively small, rural community struggle, its effects have left a global legacy.[11]

The Black Rock Forest Consortium is the focus of this narrative. The Consortium is based out of the breathtaking Black Rock Forest, a spectacular landscape, that rises high above the tumultuous Hudson River in the majestic Hudson Highlands -- a historic and once pristine landscape -- a splendid example of America's rapidly disappearing natural wonder. Acknowledging the need for environmental conservation and wildlife preservation, research and education, the Black Rock Forest has been protected by a permanent land trust and is part of an innovative association comprised of public and private K-12 schools, major universities, and several science and cultural institutions. The

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[10] For more information on the Hudson River Valley visit Hudson River Valley's Information Resource at http://www.hudsonriver.com/. This site includes a history of the Hudson River Valley; a virtual tour of the region; environmental information; updates on museums, the arts, and music resources; information on regional and State politics; and listings of relevant publications.

[11] Haynes, R. *A region steeped in history preserves its past.* Retrieved March 2004, from http://www.hudsonriver.com/

Consortium has successfully merged environmental conservation, education, and research and is dedicated to enhancing the acquisition of scientific knowledge by bridging the gaps between scientific practice and science education.

The Black Rock Forest Consortium's contributions to science education are noteworthy in their ability to connect education to the scientific process through the use of real data, hands-on experimentation, exposure to the scientific method, immersion in a landscape that is a dynamic scientific system, and by fostering interactions between educators, learners, and scientists. The Consortium's educational initiatives allow students to learn directly from nature, explore, and experiment. Teachers are being encouraged to disregard the textbook, engage in teaching activities outside of the classroom in an outdoor setting, incorporate projects based learning, and include hands-on experimentation in their teaching practices.

Educators are increasingly becoming aware that there are many ways in which ecosystems studies can strengthen education, from historical studies, to the advancement of science, to helping raise consciousness. Environmental education is multidisciplinary, merging concepts in history, ecology, outdoor education, biology, chemistry, mathematics, animal behaviorism, entomology, geology, and ethics.[12] But what many consider to be the most important goal of environmental education is the creation and development of responsible environmental behavior and ecological sensitivity in individuals. By learning about the environment, individuals are able to develop an

[12] Ramsey, J. M., & Hungerford, H. R. (1989). The effects of issue investigation and action training on environmental behavior in seventh grade students. *Journal of Environmental Education*, 23(2), 35-45.

understanding of the impact that humans are having on the planet.[13] In 1987, Hines, Hungeford and Tomera introduced four factors that are the fundamental elements of environmental education. These elements are (1) the understanding of environmental issues; (2) knowledge of actions involved with these issues; (3) ability and knowledge of how to take action on these issues; and (4) environmental responsibility and stewardship.[14]

Environmental education is cross-curricular, involving the examination and understanding of complex systems, encouraging reflection, experimentation, and analytical thinking. Environmental education encourages critical analysis, multi-layered decision making, and complex problem solving.[15] Students can be required to think independently, to examine all sides of an issue, to investigate various possibilities, to make responsible decisions, and to examine and justify the ramifications of their decisions. Often, ecosystems studies incorporates cooperative learning, in which students are working and collaborating in groups often engaging in project-based learning. These projects can support anchored instruction, in which learning is contextualized or embedded in meaningful narrative metaphors, presented in multiple perspectives, and situated in problem solving learning scenarios.

Systems dynamics is a concept that is perhaps best illustrated with environmental studies. Systems dynamics encourages learners to consider the world a series of

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[13] Trisler, C. (1993, June). *Global issues and environmental education.* Columbua, OH: ERIC Clearinghouse for Science Mathematics and Environmental Education . (ERIC Document Reproduction Service No. ED359051)

[14] Hines, J., Hungerford, H. R., & Tomera, A. N. (1986-87, Winter). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education*, 18(2), 1-8.

[15] Environmental Protection Agency. *Environmental education materials: Guidelines for Excellence, National Project for Excellence in Environmental Standards and the North American Association for Environmental Education.* Retrieved August 27 1998, from http://www.epa.gov/enviroed/naeeindx.html.

interrelated elements that have definite cause-and-effect relationships. Proponents of the systems dynamics approach to ecosystems education believe that studies of the environment should not be taught in a vacuum in which one learns isolated subjects such as chemistry, biology etc., but rather students should be exposed to the symbiotic relationships of the many different aspects of an ecosystem.[16] The very nature of our environment is that of a series of dynamic and interrelated systems. Systems dynamics involves the examination of mechanisms through feedback, control, self-regulation, and homeostasis.

The utilization of outdoor spaces should place an integral role in the study of science. Natural spaces serve as living textbooks full of tangible examples and unlimited projects and learning activities. Experiences outside with nature are healthy for all individuals' spirits, but when linked with learning they are virtually invaluable. Outdoor education takes students outside the confines of the traditional indoor classroom and brings students into the natural world. Studies conducted by Yerkes and Haras have shown that outdoor education leads to greater environmental awareness and stewardship.[17] In 1984 Driver and Johnson studied the long term benefits to students who attended the Youth Conservation Camps Program, which merged outdoor education with work opportunities for young adults ages 15-18. The study showed that the participants displayed an increase in environmental awareness as a result of the program.[18] Additional studies by Howe and Disinger and Haras and Yerkes have shown that outdoor activities

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[16] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictive investigations. Proposal to the National Science Foundation.* New York, NY: Columbia University, Lamont Doherty Earth Observatory

[17] Yerkes, R., & Haras, K. (1997, October). *Outdoor education and environmental responsibility.* Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction Service No. ED414112)

[18] Driver, B. L., & Johnson, L. A. (1983-84, Winter). A pilot study of the perceived long-term benefits of the Youth Conservation Corps. *Journal of Environmental Education*, 15(2), 3-11

engage students and help them to foster an interest in the open air, which in turn inspires them to learn about the environment.[19] [20]

Environmental education is a flexible field of study that can be brought into teaching and learning in ways that are able to incorporate many of the methodologies that lie at the cornerstone of progressive educational practices. Environmental studies involve the application of creative and critical higher order thinking skills.[21] Because environmental issues are complex and multifaceted, often involving tremendous uncertainty when developing solutions, individuals are faced with many alternatives and scenarios and are required to investigate, compare, discuss, and debate solutions. Educators are beginning to recognize that when the proper approach is applied to ecosystems studies, it can easily be in line with constructivist ideologies, in which teaching and learning takes a student-centered approach, reflecting the notion that heuristics is best achieved when learners are engrossed and immersed in contextualized learning experiences that encourage students to discover, reflect, question, and make intelligent decisions, all while developing and applying critical thinking and complex problem solving skills.

The methodology that has traditionally persisted in the American educational system has succeeded in transforming our schools into bureaucratic machines in which the school follows a factory model that uses standardization, sequencing, uniformity, is

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[19] Disinger, J. F. (1990). *Teaching creative thinking through environmental education.* Columbua, OH: Clearinghouse for Science Mathematics and Environmental Education (ERIC Document Reproduction Service No. ED331699)

[20] Yerkes, R., & Haras, K. (1997, October). *Outdoor education and environmental responsibility.* Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction Service No. ED414112)

[21] Environmental Protection Agency. *Environmental education materials: Guidelines for Excellence, National Project for Excellence in Environmental Standards and the North American Association for Environmental Education.* Retrieved August 27 1998, from http://www.epa.gov/enviroed/naeeindx.html.

concerned with efficiency, and looks upon students not as individuals but rather as products.[22] This method of teaching and learning does not encourage individuals to become thinkers and learners. It is often looked upon as a paradox, where the American educational system is intended to teach children how to think, foster creativity, and encourage cooperation, all the while forcing children to digest and accept abstracted concepts, measuring and rewarding children for following norms, and creating environments that place learners in competition with each other.[23]

Traditional learning is based on drill and practice and rote memorization of facts that are abstracted. The drill and practice, rote memorization style of learning is inflexible and behavioristic where it is simply concentrated on the attainment of desired results. It has encouraged schools to become transformed into 'bureaucratic machines' that operate as highly rigid and standardized factories.[24] Known as behaviorism, this concept is Pavlovian in nature where it is psychological rather than pedagogical, concerned with achieving a desired outcome that can be measured through conventional testing methods. Success in learning is represented by the ability, through behavior modification and exposures, to encourage individuals to produce desired responses as a result of conditioning and reinforcement. Information is presented to learners in a concise form that is hierarchical, abstracted, de-contextualized, standardized, and oversimplified and that does not take into account individual learning styles.

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[22] Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work.* Hoboken, NJ: Jossey Bass.
[23] Cuban, L. (1996). *Teachers and machines: The classroom use of technology since 1920.* New York, NY: Teachers College Press.
[24] Darling-Hammond, L. (1997). *The right to learn: A blueprint for creating schools that work.* Hoboken, NJ: Jossey Bass.

On the opposite side of the spectrum, many individuals believe that knowledge is not acquired through direct absorption; instead, individuals are actively involved in their own meaning-making, which is dependent on interactions, internalizations and interpretations. The call is for schools to provide students with the skills to understand and evaluate ideas in a way that appreciates the diversity of learners, so as to find effective learning methodologies for different types of students. Schools should help students develop the skills to be able to learn on their own, otherwise known as self-directed learning, and teachers should teach in a way that activates and engages learners.[25] These ideas have been put forth by numerous educational theorists and are manifested in the idea of constructivism, the opposite of behaviorism, which makes an effort to remedy the oversimplification and abstraction of traditional learning by appreciating the relationship of knowledge acquisition and the contextualization of learning. Constructivism is not a methodology, rather it is a philosophy. It is a pedagogical concept, subject to various and often-divergent interpretations. Constructivism takes a student-centered approach to learning, reflecting the notion that heuristics is best achieved when learners are engrossed and immersed in contextualized learning experiences.[26]

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[25] Lowry, C. (1989). *Supporting and facilitating self-directed learning*. Columbua, OH: ERIC Clearinghouse on Adult Career and Vocational Education. (ERIC Reproduction Service No. ED312457)

[26] Seymour Papert discusses the need to make learning more natural much in the way that as infants we learn language with seemingly little effort from trial and error as well as exposures and experiences with our parents and other individuals. He discusses how one growing up in France or living in France has no difficulties learning French meanwhile anyone taking French in the decontextualized and abstract setting of an American school certainly will have difficulties In his metaphor he goes on to add that we need to make learning subjects that are normally highly abstract such as math just as natural by creating something akin to a math land where students are both engrossed and immersed and where learning math is intuitive and natural. For further information I recommend reading
Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer.* New York, NY: Basic Books.

Contextualized learning, also often referred to as situated learning, is the concept that individuals learn best when they 'learn by doing' or in other words individuals learn best when learning is placed within the context of their lives. People interact with their environment changing their actions in order to enhance their understanding and discovery. When people learn by doing, they acquire experience and integrate skills, which will enable learners to transfer knowledge into real life scenarios.[27] Anchored instruction builds upon the concept of learn by doing stating that in order for learning to be effective, knowledge needs to be contextualized or embedded in meaningful narrative metaphors, presented in multiple perspectives, and situated in problem solving learning scenarios.[28]

Learner-centered learning environments emphasize that well trained educators should be able to recognize, adjust, and accommodate the abilities, skills, lifestyles, and backgrounds of children and how these characteristics impact and contribute to the learning environment. Learner-centered learning environments exist in direct contrast to the traditional behavioristic educational environment. The concept is that children have individual learning styles that must be addressed by educators. Learner-centered learning operate best when they are assessment-centered where educators continuously monitor what is and what isn't being learned and with what efficacy.[29]

Cognitive learning and development is based upon repetition and variability. Individuals are actively involved in their own meaning making that occurs internally but is sparked by external influences. The concept of cognitive flexibility notes that the

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[27] Shank, R. (1995). *Engines for education*. Mahwah, NJ: Lawrence Erlbaum and Associates.
[28] Bransford, J., & Stein, B. (1993). *The ideal problem solver: A guide for improving thinking, learning, and creativity*. New York, NY: WH Freeman and Company.
[29] Fulton, K. (2003, April). Redesigning schools to meet 21st century learning need. *The Journal of Technological Horizons in Education.*

revisiting of information using multiple approaches and representations that build on interconnections are effective in stimulating learning, memory, and recall. It is aided by conceptual variability, which is the concept that similar ideas can be best brought to life when they are embedded in different scenarios.[30]

Knowledge acquisition is best achieved with the creation of mental models.[31] Through mental models students make observations; construct interpretations of their observances; use references to contextualize the information; collaborate with other students to observe, interpret, and construct knowledge; learn through the exposure to multiple interpretations; and gain permanence and transferability by being exposed to multiple representations of the knowledge.[32]

Relevant discourse promotes learning. With cooperative learning individuals discover by communicating with others. The social construction model uses discourse and debate to encourage thought, idea formation, evaluation, and expression. Collaborative work encourages learners to consider information from the viewpoints of others. New thinking arises when individuals are faced with multiple ideas and even dissonance, forcing people to rethink and formulate new ideas. In community-centered learning environments, learning is dependent on 'intellectual camaraderie' that uses discussion and collaboration while placing learning within the context of students' lives.[33]

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[30] Palmer, D. (2002, November 11). *Piaget's Theory of Cognitive Development*. Retrieved from: http://dbweb.liv.ac.uk/ltsnpsc/AB/AB-html/node18.html.

[31] Black, J. (1992) *Types of knowledge representation. Communications, computing and technology.*- Paper. New York, NY: Teachers College.

[32] Black, J. & McClintock, R. (1995). An interpretation construction approach to constructivist design. In Wilson, B. (1995). *Constructivist learning environments.* Englewood Cliffs, N.J: Educational Technology Publications.

[33] Vygotsky. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Havard University Press.

The current charge is to transform schools into learning communities, that act as learner-centered learning environments, where content is presented in meaningful ways, personalized learning spaces and tools are supported, assessment-centered learning is practiced, communities among teachers are built, online learning and continual growth and mentoring are supported, and successful educational practices are shared and replicated.[34]

In the area of science education, the goal is to take science learning away from the pre-packaged lab and decontextualized textbook-based lessons and transform science education by linking science education to scientific practice. Bridging the gaps between learners and scientists is done through the use of real data, hands-on experimentation, the examination of working systems, modeling, and access to actual working scientists. In order to successfully blend scientific practice and science education collaborations must be established between the professional and educational arenas.

During the course of the following narrative, the formation of the Black Rock Forest Consortium will be documented along with examples of how this diverse organization has helped to bridge the gaps between the scientific and educational communities. It is of interest to examine a collaboratory consortium. This is a subject that is rarely if at all explored; the consequence is resulting in a disheartening paucity of available literature.

The Black Rock Forest Consortium illustrates that a group of institutions can band together to protect and conserve a natural resource for future generations, utilizing it for research, recreation, conservation, and education. The Consortium marks a merging of

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[34] Fulton, K. (2003, April). Redesigning schools to meet 21st century learning needs. *The Journal of Technological Horizons in Education.*

disciplines where science professionals and educators have been brought together and their efforts may be considered a prototype for the future of science and education. Ideally examining the Black Rock Forest Consortium will not only help further their efforts but may also serve as an inspiration and blueprint for future advantageous collaborations and initiatives that may be of a similar nature.

Chapter I

THE BLACK ROCK FOREST

The Black Rock Forest is a stunning 3,785-acre wilderness area whose richly forested landscape represents the true splendor of New York State. Located 50 miles north of New York City, on the western bank of the Hudson River, it is sandwiched between the preservation properties of the West Point Military Reservation -- a 15,000-acre property that is home to the nation's premier military academy -- and Storm King Mountain -- a 1,900-acre park managed by the Palisades Interstate Park. This helps to create an area with over 100,000 acres of conservation property, helping to reestablish several endangered species such as black bear, which require a substantial land area to thrive as a significant population.[35] This spectacular landscape offers breathtaking views as well as many unique and historic geological features such as spectacular peaks, rolling hills, valleys, and streams which have inspired its many visitors.[36]

Black Rock is an eastern deciduous forest that is noted as being one of the finest examples of the Hudson Valley region's natural environment. The landscape contains over 1,000 feet of varied elevation containing lakes, streams, ponds, wetlands, mountains, and forest. Because of the elevation, varied landscape, and inconsistent soil quality it has

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[35] Black Rock Forest Consortium. *Mammals of Black Rock Forest*. Unpublished Paper.
[36] For more information on the geographic features, history, and biological life at Black Rock Forest, contact the Forest headquarters at blackroc@ldeo.columbia.edu or http://wwwblackrockforest.org.

received significant less adverse human impact than the remainder of the region and therefore been able to remain a relatively unspoiled territory.[37]

Black Rock contains red and white oak, eastern hemlock, maple, birch, pine, and beech trees, and some chestnut oak remain thriving at up to 300 years old.[38] Botanically the Forest is a fascinating ecological reserve that has already had over 700 taxa of plant life identified with more than 20 plant species being categorized as rare.[39]

Black Rock also contains a varied assortment of bird, animal, and aquatic life, which live in a fantastic symbiotic harmony. Anyone walking this bucolic landscape, transversing its many miles of trails, cannot help but hear the whirs and whispers of the forest's numerous species of wildlife. As a result of the Forest's ecological diversity, Black Rock is noted for supporting many species of biological life, which have virtually disappeared from the surrounding region and whose study is of considerable scientific importance. Among the spectacular sampling of mammals that exist in the Forest are eastern coyote, red and grey foxes, black bear, weasel, bobcat, river otter, several squirrel species including the flying squirrel, beaver, muskrat, porcupine, opossum, numerous species of fish, frog, and turtle, white tail dear, and several species of bats.[40] According to the Black Rock Forest website:

> The Black Rock Forest is located at the intersection of two great ecosystems, the Hudson Highlands and the Hudson River Basin. This location contributes to the high biological diversity of the forest and the wide variety of terrestrial and

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[37] Black Rock Forest Consortium. *Where is the Black Rock Forest?* Retrieved March 2004, from http://www.blackrockforest.org

[38] D'Arrigo, R.D., Schuster, W., Lawrence, D., Cook, E., Wiljanen, M., & Thetford, R. (2001). Climate-growth relationships of eastern hemlock and chestnut oak from Black Rock Forest in the Highlands of Southeastern New York. *Tree-Ring Research* 57: 183-190.

[39] Barringer, K., & Clemants, S. (2003). *Floristic changes over time in the Black Rock Forest.* Working Paper.

[40] Black Rock Forest Consortium. *Mammals of Black Rock Forest.* Unpublished Paper.

miles from eastern Pennsylvania to western Connecticut. As a result of the Black Rock Forest's turbulent origins, it is an awe-inspiring and varied landscape noted for its uneven topography of open lowlands and mountainous peaks.

The Hudson Highlands exist west of the Hudson Valley, on the banks of the Hudson River. The Hudson River Valley was created tens of thousands of years ago, when a gigantic glacier moved its way from what is now Albany to New York City, carving a deep cavern along the way. This cavern eventually filled with water, becoming the Hudson River. The Hudson River is over 315 miles long and is a vital estuary that is home to over 206 species of fish, and numerous migratory birds, including the endangered bald eagle.[44] The Hudson River flows through New York State from its origins in the Adirondack Mountains in the northern reaches of the State to the New York City harbor where fresh water mixes with salt water coming from the Atlantic Ocean and the Statue of Liberty stands proud. The River has alternating tides that flow both upwards and downwards and the saline content of the Hudson can be measured as far north as Black Rock. As a result, of the unusual make up of the Hudson River it is noted for its extraordinary biological diversity.[45]

The River has historically been and continues to be vital to the human life and culture in the surrounding area. Thousands of years after the glacier tore through the landscape helping to carve the deep basin that would become the Hudson River, the riverbanks became home to the Algonquin, Mohegan, and Iroquois Native American civilizations. Today, the Hudson River exists as a part of the life-blood of New York

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[44] Environmental Protection Agency. *Hudson River fact sheet.* Retrieved May 22 2000, from http://www.epa.gov/rivers/98rivers/fshudson.html.
[45] Black Rock Forest Consortium. *Where is the Black Rock Forest?* Retrieved March 2004, from http://www.blackrockforest.org

State and as the River flows past the Black Rock Forest, its serpentine body becomes narrow, deep, and turbulent.

In 1609 Henry Hudson was the first European to sail up the River for which he became its eponym, traveling north from New York City to what is now Albany, stopping to anchor near the Black Rock Forest. Hudson sailed on a ship called the Half Moon with his crew of 18-20 men. Hudson and his crew had been hired for the journey by a Dutch trading company, the Dutch East India Co, and although his travel had been unsuccessful at reaching its goal of finding a passageway to China, his explorations led to the areas settlement.[46] According to The Hudson River Valley Information Resource,

> Early maps and sailing journals tell us that the area was viewed as inhospitable, with wild animals, poisonous snakes, mountains and thick forests too dense to traverse. The river itself was seen as treacherous, especially in the stretch known as the Hudson Highlands.[47]

Despite being considered a wild and dangerous region, the first settlers to the Forest followed Hudson in 1684 and were later joined by Dutch, English, and Scottish immigrants. In 1788 the town of Cornwall was incorporated, which houses the Black Rock Forest.

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[46] Haynes, R. *A region steeped in history preserves its past*. Retrieved March 2004, from http://www.hudsonriver.com/.

[47] Haynes, R. *A Region Steeped in History Preserves its Past*. Retrieved March 2004, from http://www.hudsonriver.com/.

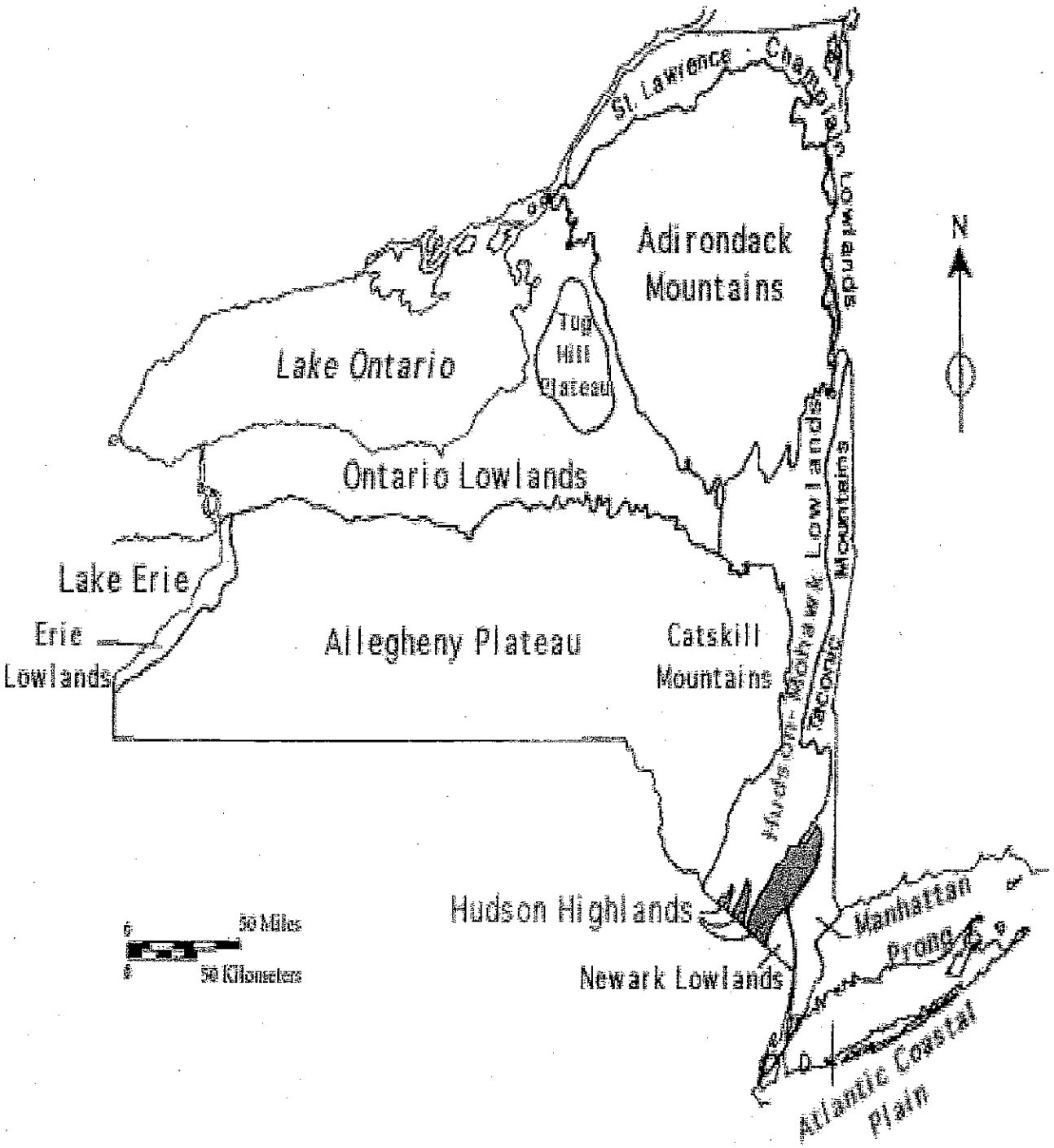

Figure 1: Map of New York State, courtesy of the Black Rock Forest Consortium.

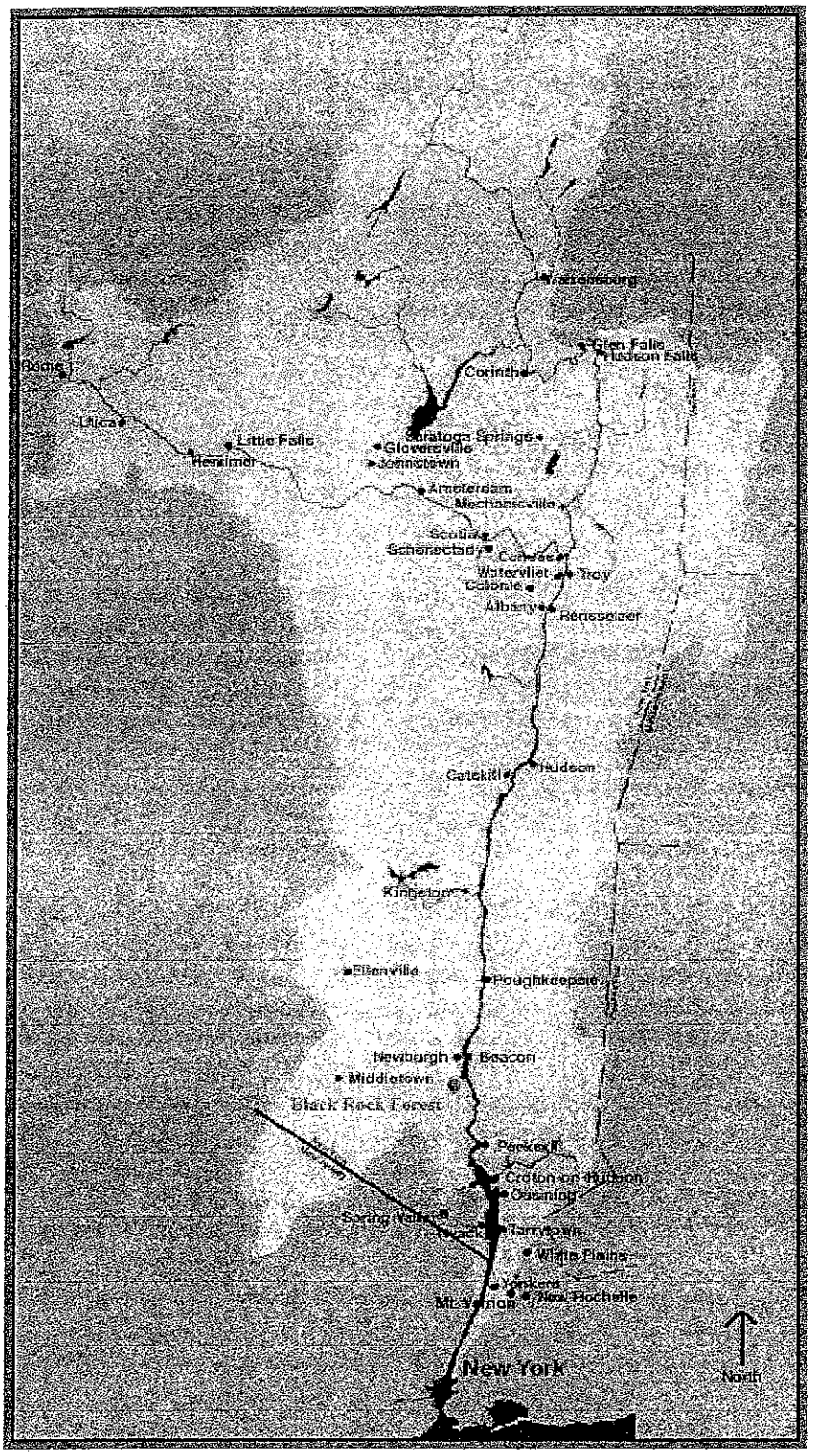

Figure 2: Map of the Hudson River its tributaries and region, courtesy of the Black Rock Forest Consortium.

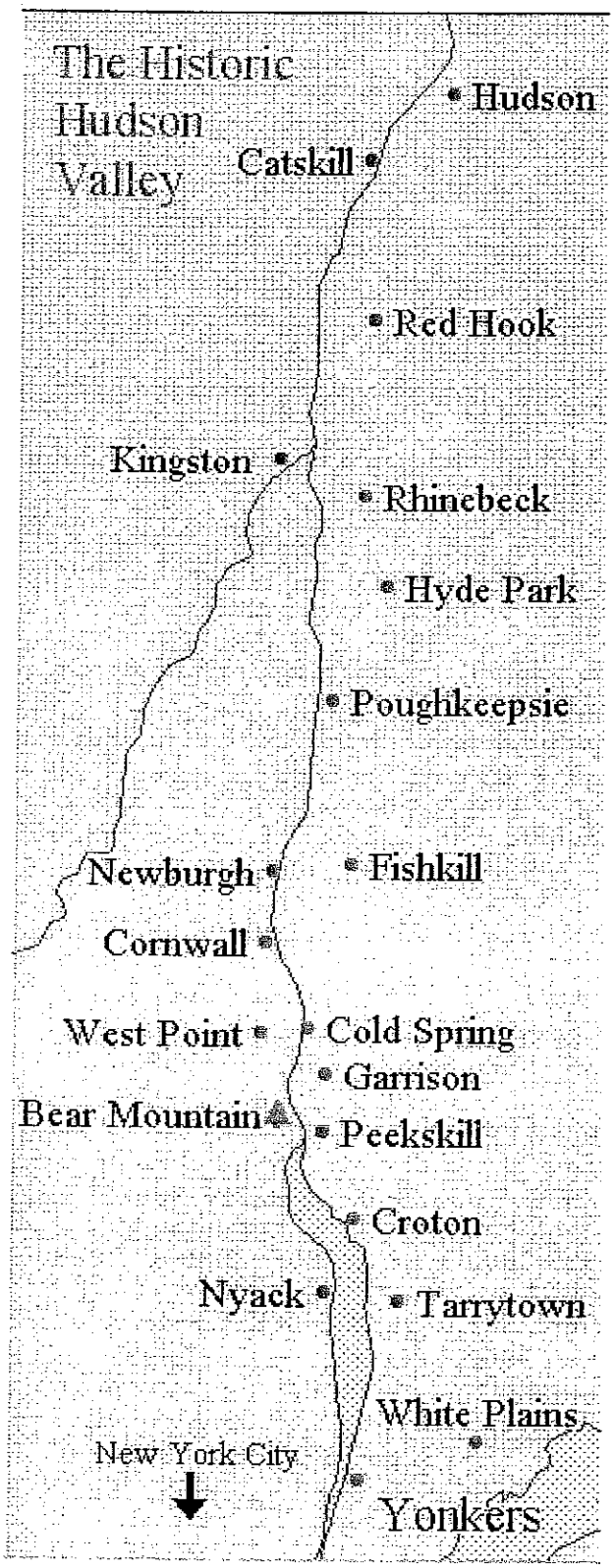

Figure 3: The Historic Hudson Valley, courtesy of the Hudson Valley Information Resource

The Hudson River Valley area has played an important role in the history of the United States. It bore witness to the Native Americans, early European settlers and explorers, the Revolutionary War, and the rise of this country's economy, trade, and transportation systems. During the Revolutionary War Americans built fortifications including West Point, Fort Montgomery, Fort Constitution, and Fort Clinton. After Benedict Arnold threatened the security of West Point by planning to help turn it over to the hands of the British, George Washington relocated his headquarters to Newburgh, N.Y. Following the war the West Point fortification expanded to become the nation's premiere military academy.

The Hudson River Valley has stimulated many great creative forces. In the early 1800's the Hudson River School of Art, led then by Thomas Cole, was so inspired by the beauty of the area that they painted their renowned landscapes.[48] Also during the 1800's the New York Knickerbocker writers, Washington Irving, James Fenimore Cooper and William Cullen Bryant, became famed authors publishing such notables as *The Legend of Sleepy Hollow, The Last of the Mohegans,* and *Rip Van Winkle.*

The invention of the steamboat in 1807 increased travel up, down, and across the River. The completion of the Erie Canal, in 1825, connected the Hudson River to the Great Lakes and the Atlantic Ocean, greatly increasing the importance of the River, as it continued to impact our nation's transportation system. Soon the expansion of railroad transportation also grew along the River's banks. As dangerous illnesses such as

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[48] The Hudson River School of Art captured our national attention for nearly 50 years, marking the first great American artistic movement. Although it was founded by and lead by Thomas Cole, other famed artists included, John Casilear, John Frederick Kensett, Sanford Gifford, Thomas Doughty, George Inness, David Johnson, Thomas Rossiter, Jasper Cropsey, Robert Weir and Frederic E. Church. Although Hudson River School of Art masterpieces can be found at many museums across the country a significant collection can be visited at the Historical Society of Newburgh Bay and the Highlands in Newburgh, New York. Additionally, many paintings are available for viewing online at the Hudson River Valley Information Resource website at http://www.hudsonriver.com/

tuberculosis began to spread the therapeutic value and fresh air of the Hudson River Valley made this region (especially the town of Cornwall which houses the Black Rock Forest) a popular health retreat lasting from the mid-1800's to the turn of the century.[49] According to Rebecca Haynes, a Hudson River scholar,

> As Americans were struggling to form their own sense of identity and culture, the Hudson Valley became a focal point, with stories and scenes from the Revolution mixed with the Dutch folklore of its earliest settlers. After completion of the Erie Canal in 1825, the Hudson River became one of the nation's main arteries of trade, opening a gateway to the west and prompting a period of major economic and industrial expansion in the area.[50]

Throughout the centuries the Black Rock Forest has been witness to the growth of the Hudson River Valley and the unfolding of our national history. The different areas of the Black Rock Forest have served a number of diverse capacities over the years, including, farming (prior to 1830); timber (1830-1850); converting wood to charcoal, otherwise known as fueling (1850-1880); tourism driven by the forest's mineral springs (1850-1910); and homesteading.[51]

The banks of the Hudson River are known for their fertile farmlands, with over one million acres of farmland being passed by and dependent upon the River. However, Black Rock's poor soil quality made it difficult to farm; as a result, throughout its history only 7.5 percent, or 270 acres, of the Forest was ever cultivated. What has been left behind to document the presence of people on the Forest are numerous remains.

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[49]Haynes, R. *A Region Steeped in History Preserves its Past*. Retrieved March 2004, from http://www.hudsonriver.com/.

[50] Haynes, R. *A Region Steeped in History Preserves its Past*. Retrieved March 2004, from http://www.hudsonriver.com/.

[51] Maher, N. (1995-1996). *Black Rock's hidden past: A history of land use practices prior to the creation of Black Rock Forest.* Unpublished Dissertation. New York University.

According to Neil Maher, author of *Black Rock's Hidden Past: A History of Land Use Prior to the Creation of Black Rock Forest*:

> Today much of Black Rock Forest's past remains hidden from view, its history covered by re-growth. Contemporary visitors must look carefully for the crumbling stone walls bordering former grain fields, the unpruned apple, pear, and cherry trees standing conspicuously in a grove of oaks, or the sudden depression in the landscape that served as charcoal pits.[52]

The Hudson Valley area has long been home to many of this country's wealthy elite, including such names as Vanderbilt, Livingston, Morse, Roosevelt, Montgomery, Irving, Rockefeller, Cole, Hamilton, UpJohn, Harriman, and Morgan. It seemed only reasonable that the successful financier and President of the National City Bank James Stillman would seek to build his estate along the River's banks. In 1885, Stillman began purchasing the land that is now known as the Black Rock Forest. He started with a single tract of land, adding to his initial purchase over the next three decades. Throughout his ownership, Stillman allowed the land to be aggressively logged. His dream was for this land to eventually be developed into a retreat for his family; however, this vision never came to fruition, and he left the land in a state of degradation.[53]

In 1918 James Stillman died, leaving the undeveloped land to his son Ernest Stillman, a local medical doctor and a man concerned with healing. Ernest was not only concerned with healing the forest but was also concerned with protecting it from further abuse.[54] Although Ernest did not discontinue the practice of woodcutting, his concerns for the environment made him shift to adopt the new practice of sustainable forestry.[55]

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[52] Maher, N. (1995-1996). *Black Rock's hidden past: A history of land use practices prior to the creation of Black Rock Forest.* Unpublished Dissertation. New York University.

[53] Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*

[54] Much of the Hudson River Valley had been clear cut and or damaged as a result of industrialization, as a result the U.S. government created the Division of Forestry, and protected parks began to be established.

Sustainable forestry takes into account the long-term effect on the environment, and its growth and popularity are often attributed to President Theodore Roosevelt. Roosevelt who was influenced by the ideas of Gifford Pinchot, a man later appointed by President Roosevelt to Chief of the Division of Forestry of the Department of Agriculture in 1898 and who served as the head of the newly created United States Forest Service, following his appointment in 1905. Gifford Pinchot believed that the goal for any forest should be "the greatest good to the greatest number for the longest time."[56] Issues of human population growth and America's irresponsible land-use practices concerned him.

Richard Thorton Fisher -- a close friend of Ernest Stillman and former student of Gifford Pinchot -- who was then director of the Harvard Forest at Petersham while visiting the Stillman property in 1926, recommended that Ernest establish a sustainable experimental forest.[57] With this conservation ethic in mind, Ernest Stillman expanded the acreage and started actively funding forestry research and scientific experiments, founding Black Rock in 1928, which was named after one of the mountains located within the Forest's boundaries. Fisher remained interested in his commitment to Black Rock, overseeing research and activities. Fisher stated in Black Rock's first bulletin, in 1930, that the Forest was designated to serve as a "laboratory for research in problems of forest management and for the demonstration of successful methods in practice." Fisher also noted "the Black Rock Forest represents a region where the problem of the future use

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The earliest effort in the region was started by the Palisades Interstate Park Commission which worked to purchase or acquire via donation land along the western bank of the Hudson creating the Bear Mountain and Harriman State Park.

[55] For more information on the Stillman family and their uses and treatment of the Forest refer to: Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.

[56] Pinchot, G. as quoted in Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.

[57] Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.

of land use is of particular economic and social importance and where but little systematic work has been done to solve it."[58]

During the early years of Black Rock the ecological protection and restoration of the Forest became a concern as the stewards worked to help the Forest recover from previous exploitation. The caretakers kept detailed documentation of their efforts as well as the operations of the Forest. Experiments and investigations in forestry, botany, geology, and soil science occurred resulting in the publication of the first series of Black Rock Forest papers and Bulletins. In 1930, a series of plots were established for long term investigation that have been monitored for over 70 years.

Having now become an avid conservationist and person interested in forestry studies, Ernest Stillman sent a letter to Dr. James B. Conant, then President of Harvard University, in 1940. In the letter, he outlined his plans to have Harvard take over Black Rock upon his death, which he referred to as "a barely explored academic goldmine".[59] He also outlined his intention to form an endowment to fund research to be conducted at both Harvard's existing experimental forest at Petersham, Massachusetts and the Black Rock Forest.

> The Black Rock Forest in its 12 years of life has already produced so much valuable scientific knowledge that it seemed a shame to have these experiments terminate at my death. Three alternatives presented themselves: (1) establish an individual foundation; (2) deed the property to the Bronx Botanical Park, Syracuse, or Cornell Universities; or (3) deed the property to Harvard University....
> I naturally favored the last, as I believe the Black Rock Forest would be complimentary to the Harvard Forest.[60]

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[58] Fisher, R. (1930). *Black Rock Forest Bulletin.*
[59] Stillman, E. as quoted in Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*
[60] Stillman, E. as quoted in Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.

Upon Ernest Stillman's death, in 1949, he bequeathed the Forest, along with an endowment, to his alma mater, Harvard University, which accepted the Forest and agreed to maintain it along with their closer-located and better-known forest at Petersham, which was also receiving some of the funds donated by the Stillman family. The total of the Stillman endowment in 1949 was an impressive $1,154,861.57.

> I give and devise to the President and fellows of Harvard College, Cambridge Massachusetts, all of that tract or parcel of land situated in the Townships of Cornwall and Highland Falls, New York, known as the Black Rock Forest, which for many years has been operated by me as an experimental forest, together with all of the buildings situated on said tract and the contents of such buildings.[61]

In the year that Black Rock was endowed to Harvard, Calvin Stillman, son of Ernest Stillman, suggested that Harvard focus less on issues of forestry and more on scientific study and experimentation. He wrote, "the forest should … devote its energies to the one factor most surely fixed -- pure science."[62]

After taking over Black Rock, Harvard built a small research laboratory and office building. During Harvard's tenure with the Forest, modest research studies were conducted, resulting in the publication of several research bulletins. These papers focused on issues such as microclimate studies, wildlife studies, root-system studies, and the analysis of recreational potentials.[63]

Throughout their ownership of Black Rock, Harvard put most of its attention to its other owned and operated forest, located in closer proximity to Cambridge, at

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[61] Stillman, E. as quoted in Crompton., Snyder., & Wilson. (1973, January). *The Cornwall pumped storage project and the Black Rock Forest.* Report to Bok Harvard University.
[62] Stillman, E. as quoted in Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.
[63] A complete list as well as copies of Black Rock Forest Bulletins is available via request by contacting Black Rock's headquarters at blackroc@ldeo.columbia.edu

Petersham.[64] With this attitude the Forest became looked upon by Harvard as an underutilized financial burden that cost them $32,000 annually; however, it is important to note that at no time had the costs of maintaining the Forest exceeded the income generated by the Stillman endowment.[65]

Although the Black Rock Forest and a considerable endowment were presented to Harvard by Ernest Stillman, specific instructions for their use was never outlined by Stillman.[66] Throughout the years following Harvard's inheriting of the Forest and receipt of the financial endowment Harvard was dividing a portion of the income earned by the Stillman endowment and allocating these monies between Petersham and Black Rock. The distribution, however, was far from equitable. While Black Rock was receiving 30 percent of the income, Petersham was receiving 70 percent.[67]

The point of view of Harvard toward Black Rock is best exemplified in the words of Daniel Steiner, former chief council of Harvard, who said, "[F]rom the point of view of our scientific community in biology, it does not offer anything unique in comparison to a forest much closer and where we have a large facility."[68] As a result, until 1962 Harvard acted almost as an absentee landlord of Black Rock; however, in 1962 things began to change, as Black Rock became immersed in a bitter struggle. This struggle marks what is Black Rock's most important legacy to date, as it set national precedent

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[64] Karnig, J. (personal interview, 2000).
[65] Golden, W. (personal interview, 2000).
[66] Foderaro, L. (1989, August 25). Harvard will sell a forest, a legacy From an alumnus. *New York Times.*
[67] Williams, L. (1985, November 15). Harvard amid opposition, plans to sell upstate forest given by alumnus. *New York Times*
[68] Steiner, D. as quoted in Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker.*

and what most environmentalists agree sparked the birth of America's environmental movement.[69]

The famous Black Rock Forest Con-Ed Controversy, also known as the Storm King Mountain Lawsuit, lasted from 1962-1980 marking a 17-year struggle to protect the environment. The struggle began when Consolidated Edison submitted plans to build a hydroelectric pumped-storage-and-electricity-generating station in the Forest. Harvard officials toyed with the idea of selling a portion or all of the property to Consolidated Edison. This would have involved condemning a section of the Black Rock property. Opponents of the project felt that Harvard had been easily swayed by Consolidated Edison and viewed the proposed project as a way for Harvard to rid itself of Black Rock and keep the Stillman endowment.[70]

The Con-Ed project entailed pumping water from the Hudson River to a reservoir holding station built high atop the Highlands, where the water would remain until it could be released through tremendous turbines located at the base of the mountain. The Con-Ed project would have involved the expansion of the upper reservoir, the cutting of 240 acres of the Forest for flooding, and the addition of numerous roads. As a result of the permanent changes noted in the Con-Ed project, individuals in the community became deeply concerned. The proposed actions sparked fear and raised significant environmental concerns. Issues of pollution, seepage, water quality, and impact on indigenous species became quandaries that influenced much interest and debate. As one opponent of the Con-Ed project claimed, "This instability of the ground was not

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[69] Environmental Protection Agency. *Hudson River fact sheet.* Retrieved May 22 2000, from http://www.epa.gov/rivers/98rivers/fshudson.html.

[70] Williams, L. (1985, November 15). *Harvard amid opposition, plans to sell upstate forest given by alumnus.* New York Times

recognized. Neither was the fact that the Hudson River is an estuary and not a one way stream."[71] Regardless of opposition from local residents, Con Ed showed commitment, applying to the Federal Power Commission (FPC) for a license to operate a hydro-electric facility. After the FPC's initial granting of approval for the project three years of hearings and appeals followed, resulting in the United States Court of Appeals decision to order the FPC to rehear the case and this time allow environmental impact testimony. This marked a precedent setting decision where for the first time the U.S. government acknowledged the importance of environmental impact studies.[72] In 1966 a new round of hearings began in front of the FPC that lasted for four years. Conservationists were not deterred after the FPC decided to grant a license to Con Ed in 1970, challenging the water quality permits required for the project. Following a fishery study in 1974 the appeals court once again ordered more hearings keeping the controversy alive for another six years.[73]

These concerns for the land became an impetus to what initially began as a small intervention from the local community and environmental interest groups. Quickly this controversy became a statewide campaign and even sparked the formation of several environmental groups, which still exist today. It is important that this struggle is not minimalized. Soon after its inception, this conflict became a national concern. This battle became part of a legal action known as the Storm King Mountain Lawsuit, with a transcript of 18,000 pages. This case was brought by Scenic Hudson as well as by the

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[71] Lamb, J. (personal communications, September 10, 1998). *The history of the Black Rock Forest Cornwall New York.* Unpublished Memoir. Black Rock Forest Consortium Files

[72] Haynes, R. *A region steeped in history preserves its past.* Retrieved March 2004, from http://www.hudsonriver.com/

[73] Haynes, R. *A region steeped in history preserves its past.* Retrieved March 2004, from http://www.hudsonriver.com/

Natural Resources Defense Council (NRDC), both of which were formed as a result of the controversy. Both organizations continue to exist today working to champion environmental causes. Scenic Hudson focuses on environmental conservation and stewardship in the Hudson Valley. NRDC is a major national environmental organization, which was formed in 1970 by Steven Duggan, a lawyer and local resident, his wife Smokey Duggan and a number of their friends and colleagues. NRDC is a permanent national not-for-profit group dedicated to using the power of science and our legal system to champion environmental causes. Currently, NRDC has 400,000 members and a staff of lawyers, scientists and environmentalists. Among the other groups involved in the Black Rock Forest struggle were the Palisades Interstate Park Commission; the City of New York; the Sierra Club and its Atlantic Chapter, the Wilderness Society; the Izaak Walton League of America; Clearwater, the National Audubon Society; and the National Parks and Conservation Association.

Led by Steven and Smokey Duggan, the opposition battled tirelessly for the protection of the Black Rock Forest and inspired many Harvard students, who made the three-and-a-half-hour pilgrimage to demonstrate against Con-Ed. The Harvard University newspaper, *The Crimson*, ran a front-page headline that read, "Black Day at Black Rock."[74]

The case helped to inspire the National Environmental Policy Act (NEPA), which Harvard acknowledged was a notable achievement. The NEPA was signed into law by President Nixon on January 1, 1970 and formally declared national environmental policy and goals for the protection and maintenance of our natural resources. It requires all

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[74] Williams, L. (1985, November 15). Harvard amid opposition, plans to sell upstate forest given by alumnus. *New York Times*

federal agencies to prepare environmental impact statements when proposing actions that may effect the environment. The NEPA also created the Council on Environmental Quality (CEQ) in the Executive Office of the President.

The battle raged on for 17 years, and when the controversy was finally resolved (out of court, by a mediator), in 1980, the victorious outcome of this historic battle provided a major win for the environment, leaving an illustrious and inveterate legacy. In the end, Con-Ed agreed to halt construction of the plant and to establish an endowment along with the other utility companies in the region to fund independent research on the impact of power plants on the aquatic life of the area. Russell E. Train, a former administrator with the Environmental Protection Agency and mediator of the dispute, referred to the settlement as the "Hudson River Peace Treaty."[75]

With the nation having borne witness for almost two decades, the end of the controversy received a lot of notoriety in the popular press. An article in the December 20, 1980 edition of *New York Times* predicted that the agreement would serve as a model for future settlements around the country.[76] This prediction proved true as the positive outcome in the Storm King Mountain lawsuit encouraged and empowered communities to take charge of their environmental legacy. It set a precedent for environmental activism encouraging small communities and environmental groups to battle and win cases against major corporations in order to protect their natural resources.[77]

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[75] Smolowe, J. (1980, December 20). Con-Ed to drop Storm King Plant in wide-ranging pact on Hudson. *New York Times*

[76] Smolowe, J. (1980, December 20). Con-Ed to drop Storm King Plant in wide-ranging pact on Hudson. *New York Times*

[77] Haynes, R. *A region steeped in history preserves its past.* Retrieved March 2004, from http://www.hudsonriver.com/

Individuals living in the Hudson Valley area are well aware of its ecological and historical significance, and the concern for protecting the Hudson River Valley continues today as over-development threatens the region. Today, the Hudson Valley area is protected by such movements as the American Heritage Rivers initiative in addition to numerous Hudson River Valley community and citizen groups such as Scenic Hudson, the Hudson River Sloop Clearwater, Historic Hudson Valley, the Adirondack Council, the Open Space Institute, the Hudson River Foundation, Historic River Towns of Westchester, the Hudson Riverkeeper, and the Nature Conservancy. According to the Environmental Protection Agency:

> The modern environmental movement was born in the Hudson Valley with the Scenic Hudson decision, which established the precedent for the National Environmental Policy Act. It was on the Hudson that the idea of having a Riverkeeper, a watchdog for environmental disturbance, developed. There are now several Riverkeepers across the country which are based on this model.[78]

In recent years, a lack of affordable housing in areas in close proximity to New York City and the expansion of available transportation is causing the Hudson Valley to experience a large population influx. This new population requires housing, shopping, roadways, and services, which have created a very lucrative building market. This building market is causing the development and degradation of much of the nearby landscape, therefore making environmental conservation and stewardship increasingly more vital to the area.

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[78] Environmental Protection Agency. *Hudson River fact sheet.* Retrieved May 22 2000, from http://www.epa.gov/rivers/98rivers/fshudson.html.
Environmental Protection Agency. *What is America's Heritage Rivers Initiative.* Retrieved May 22 2000, from http://www.epa.gov/rivers/initiative.html.

As a result of the Con-Ed struggle, Harvard was forced to reevaluate their role as owners of the Black Rock Forest. While still engrossed in the midst of the controversy Harvard established a committee to study the proposed project and to make recommendations as to the future of the Forest. The committee was comprised of, Alfred W. Crompton, a professor of Biology and director of the Museum of Comparative Zoology at Harvard; William E. Reifsnyder, a professor of forest meteorology and public health at Yale; and Richard Wilson, a professor of physics at Yale. Individuals who contributed to the committees work included John Lindsay, former mayor of the City of New York; Dr. Calvin Stillman, son of donor Ernest Stillman; and Chauncey Stillman, nephew of Ernest Stillman.

The committee released its final report in January 1973, making in the midst of the battle three recommendations for the future of the Black Rock Forest. The first suggestion was that Harvard sell the Forest to a private individual so that the land could become part of a large private estate. The second recommendation was for Harvard to sell the land to Con Ed and ask them to donate much of the forest to the Palisades Interstate Park. The third and most noteworthy suggestion, and the one that would spell the future of the Black Rock, stated, "Harvard could investigate the possibility of leasing the forest to N.Y. universities for establishing a biological field station." In this report the committee recognized that "in terms of training students it is often highly desirable that the field station be readily accessible" and that this would "relieve Harvard the cost of maintaining the Black Rock Forest"[79]

[79] Crompton., Snyder., & Wilson. (1973, January). *The Cornwall pumped storage project and the Black Rock Forest.* Report to Bok Harvard University.

Following the release of the committee's report, Daniel Steiner, then general counsel of Harvard, contacted his friend and neighbor William Golden, a noted scholar, businessman, lover of science, and philanthropist, seeking suggestions for the future of the Forest. At this juncture, it is important to introduce Mr. William Golden, as he played an integral role in the Forest as it progressed from the hands of Harvard University to the Black Rock Forest Preserve and is responsible for the formation of the Black Rock Forest Consortium.

Mr. William Golden

William Golden has had a love of science since childhood. He received his undergraduate degree from the University of Pennsylvania and attended graduate school at Columbia University and the Harvard University School of Business. The University of Pennsylvania, Columbia University, Polytechnic University, Hamilton College, and Bard College have awarded him honorary doctorates.

Mr. Golden has had tremendous success in business, initially as a securities analyst on Wall Street, then as chairman of the National Radiator Corporation among other boards of directors. Currently he is the director of several corporations, including General American Investors Company and Block Drug.

His career in public service has been long lasting and well noted. He joined the United States Navy in 1941 and quickly became an officer. Later, he was invited by President Truman to become a member of the first U.S. Atomic Energy Commission. He has also aided the Department of State and has served as special assistant to the Executive Office of the President under President Truman, where he designed the first President's Science Advisory Apparatus and served as an advisor on the formation of the

National Science Foundation (NSF). As a result of these achievements, in 1982, Mr. Golden received the Distinguished Public Service Award of the National Science Foundation and a special Tribute of Appreciation in 1991. These experiences are also reflected in his publications.

His interests in history, science, and conservation are also expressed in his involvement in the nonprofit sector. He is on the board of numerous organizations, including the American Museum of Natural History (chairman emeritus), the American Association for the Advancement of Science (treasurer), the New York Academy of Sciences (life governor, former president), Barnard College (vice-chairman emeritus), the Golden Family Foundation (president), and the Black Rock Forest Consortium (founder and chairman).

Today, Mr. Golden continues to be an active contributor to many organizations and has committed himself to the enhancement of scientific research. His role with the Black Rock Forest Consortium has been instrumental in its development and success. It is also important to note that without his assistance this case study would not be possible. He has been forthcoming with his vast memory as well as willingly allowing me into the his extensive archives as well as the records of the Black Rock Forest Preserve and the Black Rock Forest Consortium.

The Formation of the Black Rock Forest Consortium

Following the release of the 1973 report that suggested as possible options for the future of the Black Rock Forest the leasing of the Forest to a number of New York-based academic institutions; Daniel Steiner, vice president and general counsel of Harvard,

contacted Golden, his longtime friend and neighbor, asking him to review the report and for his suggestions for the future of the Harvard Black Rock Forest.

After speaking to Daniel Steiner and reviewing the Harvard committee report, Mr. Golden, who at that time was serving among other things as chairman of the board of the American Museum of Natural History (AMNH) as well as corporate director and trustee of the American Association for the Advancement of Science, made a trip to the Black Rock Forest accompanied by his wife and daughter. As part of his research, Mr. Golden spoke with several individuals from Harvard and the community, including Stephan Duggan, founder of the Natural Resources Defense Council and avid opponent to the proposed Con-Ed Project. A few days following his visit to Black Rock, Mr. Golden went to Cambridge and had the opportunity to meet with Daniel Steiner to speak further about the future of the Forest.

With his initial exploration completed, and following some careful thought and consideration, Mr. Golden began to develop his vision, noting it in virtually identical letters to both Daniel Steiner and Anne Sidamon-Eristoff, who was then a trustee of the American Museum of Natural History.

> Conceivably the Forest could be operated by the American Museum for Natural History as a field station or by a consortium of local institutions including the AMNH, the New York Botanical Garden, the Brooklyn Botanic Garden, and the New York Zoological Society. Such a consortium, under the leadership of one manager, should be able to use the Forest relatively intensively for scientific and ecological purposes while preserving and improving its character and maintaining it as an enclave of nature in the growing community by which it is surrounded.[80]

Daniel Steiner took Mr. Golden's advice into account; however, Harvard made no moves toward a sale following Mr. Golden's 1973 letter. The future of Black Rock

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[80] Golden, W. (personal communications, March 28, 1973). Letter to Daniel Steiner.

remained uncertain for several years as the Con-Ed controversy waged forward. Discussions regarding a possible sale of Black Rock picked up again in the summer of 1981, following the resolution of the Con-Ed controversy.

Mr. Golden remained in contact with Daniel Steiner over the ensuing years following his meeting with Steiner and visit to Black Rock, which kept him abreast of Harvard's continued interest in the sale of the Forest. In August 1981, William Golden dictated a memo, which became the first memo to be filed regarding the then-named Harvard Black Rock Forest. In the memo he noted that the American Museum for Natural History could still purchase the landscape; however, he was concerned as to the future operating costs, which he predicted would rise from the then $32,000 spent annually by Harvard. He concluded that it would be economically prudent for the Forest to become part of a larger consortium of organizations.

> The major notion at this time, as an alternative to the AMNH, is that a new not for profit cooperation, say the Black Rock Forest Foundation, would be organized to acquire and manage the property.
>
> The new foundation would make arrangements with several organizations for partial use of the property. Thus, it may be that not only the American Museum of Natural History but also the Brooklyn Botanic Garden, Barnard College, Columbia University, City University, New York University, certain other universities and colleges in the New York and Mid-Hudson area, would very much like to use parts of the Forest on an occasional basis but would not find it operationally necessary or financially feasible to have the full responsibility.[81]

In retrospect, Golden attributes the inspiration for his vision to form a consortium to the University Corporation for Atmospheric Research (UCAR), an organization he was familiar with that operates the National Center for Atmospheric Research in Boulder, Colorado. UCAR comprises a group of member universities that all have meteorology

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[81] Golden, W. (personal communications, August 26, 1981). Memo to File Regarding Harvard Black Rock Forest.

departments and have successfully agreed to share a valuable resource that in this instance happens to be a telescope. Mr. Golden recognized that it is advantageous for a group of organizations with limited financial means to come together to share a resource. "So these are groups of educational institutions running laboratories or observatories, and I thought a comparable organization would be a good way to run the Black Rock Forest."[82]

After some further brainstorming, Mr. Golden, aided by his legal council Helene Kaplan, developed a preliminary list of 15 scientific and educational institutions that they thought would be interested in becoming part of the proposed consortium, acknowledging that it would be difficult to get these institutions sold on the idea and onboard to spend money. At this point, Mr. Golden was already seeing himself as the future purchaser and benefactor of the Black Rock.[83]

With the list of potential consortium members completed, on November 6, 1981 Mr. Golden sent out an initial letter of inquiry. In the letter he discussed the wonderful environmental landscape that is Black Rock, as well as addressed the question of the benefits of a coalition of institutions sharing the resource.

> At the invitation of the Harvard administration, I have discussed with them the possible purchase of the Harvard Black Rock Forest at Cornwall, near West Point, New York, by a not-for-profit corporation to be established....
>
> The basic question is whether, with the growing interest in forestry, ecology, animal behavior, orgasmic biology, and nature studies broadly defined, a consortium of universities, colleges, secondary schools, and other institutions, such as the American Museum of Natural History, would like to have the right to use this property from time to time. No one of them is likely to have enough need for it to justify the full operating expense or to undertake the responsibility for management; but it might be utilized effectively at all seasons by a consortium of associates. Management would be provided by the not-for-profit cooperation, which could

[82] Golden, W. (personal interview, 1999).
[83] Golden, W. (personal interview, 2000).

> schedule the use by Associates in a manner comparable to the allocation of telescope time at major observatories.
>
> If sufficient interest is displayed, not only would funds be available for the purchase of the property but also in addition operating funds would be provided for a trial period during which it would be determined whether usage by the educational institutions is sufficient to justify the expense and managerial attention. Should the arrangement prove sufficiently popular, it is contemplated that use charges would be established in amounts sufficient to make the organization self supporting... As indicated, the purchase cost and fund of working capital would be donated.
>
> The purpose of this letter is to explore in a preliminary, but practical and timely, way whether there is sufficient interest by a number of appropriate and congenial institutions to warrant the expenditure of time and treasure by the potential donor....[84]

Much to Mr. Golden's delight, most of the institutions contacted expressed interest in his letter, recognizing that they could benefit by the educational and research possibilities of the Black Rock Forest, as well as by collaborating with other prospective consortium members. Interested parties were strongly encouraged to visit the Forest. Robert Steubing, a professor of English and Philosophy at Ulster County Community College, was placed in charge of scheduling Forest visits and correspondence. Jack Karnig, the resident Forest manager, who had been in service since 1959, met with many of these representatives, giving tours of the landscape.

Helene Kaplan had developed the idea to place the Forest not directly into the hands of a consortium but rather into a separate nonprofit organization that would guarantee the protection of the Forest should the consortium fail. It had been decided that the Forest would be sold to a not-for-profit that would be established and called the Black Rock Forest Preserve and that the preserve would lease the land to the consortium for the nominal fee of $1 annually. Kaplan and Golden also realized that in order for the consortium to be successful it would need to have full authority for the Forest. They

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[84] Golden, W. (personal communications, November 6, 1981). Letter to potential Black Rock Forest Consortium members.

hoped that these decisions would help allay the concerns of the community, the attorney general, and Harvard, who were all skeptical of the proposed consortium.[85]

Keeping with their vision they decided that a board of directors elected by the members of the consortium would have governing power over the day-to-day running of the Forest; however, ultimately, ownership and control of Forest funds would be the responsibility of the preserve. It also was deemed wise at that time that Jack Karnig remain in his post, as he was most familiar with the day-to-day operations of the Forest and an active member of the Cornwall community.

Following the tremendous response from Mr. Golden's letter to prospective members Mr. Golden was eager to move forward with his plan to purchase the Forest and form the diverse association. As a result, a luncheon meeting was scheduled consisting of prospective consortium members, in which Mr. Golden planned to outline his vision formally and explain the logistics of the plan. The meeting of interested parties was held on September 13, 1982 at the Century Association in Midtown Manhattan. In attendance were William T. Golden, Helene Kaplan, Sibyl R. Golden (Mr. Golden's daughter and an editor of science books), Jack Karnig, Robert Steubing, and Daniel Steiner. The potential consortium members who sent representatives included the American Museum of Natural History, Bard College, Barnard College, Brearley School, Brookhaven National laboratory, Brooklyn Botanic garden, City College of the City of New York, Collegiate School, Dalton School, Ethical Culture Schools, Fordham University, Graduate School and University Center City University of New York, Hunter College, Lehman College, Manhattan College, Masters School, New York University, Storm King School, and the United States Military Academy at West Point.

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[85] Golden, W. (personal interview, 2000).

The luncheon was considered to be a success, with many of the institutions expressing interest in membership. Following the luncheon, a summary memo was generated by Mr. Golden and sent to all those who had been in attendance. In that memo he explained that initially he would limit membership in the yet-to-be-formed consortium to no more than 12 member institutions for the first year and that he wanted to receive letters of commitment form those institutions that plan to participate.[86]

In the few months following the Century Club Luncheon, Mr. Golden continued negotiations with Harvard as well as community groups who also had an interest in the future of Black Rock. Mr. Golden was particularly concerned that the proposed consortium be welcomed into the community. During one of our many discussions, he recalled, "I thought it would be important that we be welcomed in the community or at least not regarded with hostility as outsiders."[87] He attributed the favorable reception he received from the community largely to several key community members who helped introduce Mr. Golden and who attested to his good intentions and general concern for the future of Black Rock. Among these instrumental individuals were Stephen Duggan, who had led the struggle against Con-Ed, and Jack Karnig, the Forest Manager who was at that time employed by Harvard.

Following the meeting of interested parties at the Century Association, Mr. Golden had received a sufficient number of letters of intent from groups that intended to become members of the consortium. As a result, in September of 1983 Mr. Golden sent a letter of update to all parties involved, in which he acknowledged the lethargy with which the negotiations with Harvard were progressing.

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[86] Golden, W. (personal communications, September 21, 1982). Memoradum to all who attended the Black Rock Forest Associates luncheon.
[87] Golden, W. (personal interview, 2000).

> When I initiated this project, with the encouragement of Harvard University, neither I nor they had any idea how slowly it would progress. Factors beyond my control or influence have occasioned the delay. However, Harvard does have the program under serious consideration, and I am hopeful that the outcome will be favorable, for I believe that it would be beneficial educationally, scientifically, and ecologically. But I cannot be certain of the outcome, nor can I predict the timing.[88]

The factors that Mr. Golden referred to as beyond his control included approval from the Black Rock Forest Preservation Council -- a group established by the mayor of the town of Cornwall and comprising state and local civic and business leaders who sought to ensure that the Forest did not pass into the hands of any organization that sought to use it for commercial or development means.[89]

As a result of the negotiations between Harvard and Mr. Golden, who was represented by Ms. Kaplan, a few things had been established: It was agreed that the property would be sold to the Golden Family Foundation; that it would be leased to a consortium of universities, K-12 schools, and science and cultural institutions; and that the Golden Family Foundation could not sell the land at any time. It was agreed that if the consortium failed financially, the Forest would pass into the hands of New York State, the Palisades Interstate Park Commission, or Scenic Hudson. It was also agreed that the price would be $400,000, which was considerably lower than the $4 million that Harvard initially saw as a reasonable price. But perhaps the biggest issue faced was what was to become of the endowment left to Harvard with the donation of Black Rock by Ernest Stillman.

When Ernst Stillman endowed Black Rock to Harvard University, he left an endowment of $1.2 million. That endowment had grown to approximately 2.5 million

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[88] Golden, W. (personal communications, September 21, 1983). Letter to potential Black Rock Forest Consortium members.
[89] Golden, W. (personal interview, 2000).

dollars by 1985. Since it had received the bequest, Harvard had used 70 percent of the trust's income for research conducted at the Harvard Forest at Petersham, with 30 percent of the funding going to Black Rock. Harvard was planning to keep the endowment after selling the property to the Golden Family Foundation. Harvard stated at the time and still contends that the endowment and the Forest are separate and that Ernest Stillman's will did not stipulate that the money from the endowment would remain with the forest. "There was no legal restrictions placed on either the endowment or the forest. Dr. Stillman's trust was to benefit both the Harvard Forest and the Black Rock Forest," noted Nancy D. Israel, a Harvard attorney.[90] Individuals from Harvard claimed that the endowment was meant to aid Harvard's research in forestry not to be used specifically for Black Rock. The disagreement over the endowment angered individuals from the Cornwall community, Harvard, environmental groups, and the Stillman Family.

Many individuals criticized not only Harvard's decision to sell the Forest but Harvard's very treatment of the Forest and what many perceived to be a misuse of funds. As a result, Harvard's treatment of the Forest began receiving national attention. On June 11, 1984, *The New Yorker* published an almost 40-page article titled "Annals of Discourse: The Harvard Black Rock Forest." The article criticized Harvard for its lack of dedication to the vision of the pioneers of environmental conservation such as Gifford Pinchot, and Richard T. Fisher, and for failing Ernest Stillman, the generous benefactor who not only donated the property but also established a considerable endowment.

> Of Harvard and its relationship to the Black Rock Forest, to the Stillman family of benefactors, to the science of silviculture, it should be said that ... Harvard University has been looking closely, ruthlessly at its assets.... Recently Harvard

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[90] Israel, N. as quoted in Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.

> University decided that the Black Rock Forest ... had not performed and should be sold.[91]

The article went on the question Harvard's motives and even went so far as to suggest that Harvard's primary objective was to keep the Stillman endowment, relieve itself of the small burden of maintaining the Forest, and manage to make a profit of the Forest's sale.

To represent Harvard's point of view, the author interviewed Daniel Steiner regarding his feelings toward to the Forest.

> It is clear to us that Harvard is not a conservation organization. Dr. Stillman understood that. The bequest of the forest is absolute. To Harvard, without restriction. There is well known language to be used in wills if you want to restrict a bequest: alternative dispositions of property if the university does not carry out his wishes. He did not use any language of this kind.... I think it would be wrong to make an assumption that Dr. Stillman had required, or even expected that Harvard hold on to it. If I were interested in preserving a forest, I wouldn't give it to a university. At the same time, we've looked at the land, looked at the area, and it seems inappropriate to sell it for development. Although under the terms of the will, flat out, we legally could.... My conscience is clear.[92]

A *New York Times* article published in January 1985 focused on the proposed transaction. The article discussed the pending venture, shedding favorable light on the proposed consortium. The article, however, was very critical of Harvard and questioned their decision to profit from the sale and keep the Stillman endowment, choosing to quote George W. Gowen, a Harvard alumnus and chairman of Scenic Hudson, who said, "We believe Harvard is betraying trust."[93]

On May 23, 1985 a certificate of approval was signed by Dawn A Sandifier, justice of the Supreme Court of the State of New York, and Robert Abrams, attorney

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[91] Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.
[92] Biltmore. (1984, June 11). Annuals of discourse: Harvard Black Rock Forest. *New Yorker*.
[93] Gowen, G. as quoted in Williams, L. (1985, January 15). Harvard amid opposition plans to sell upstate forest given by alumnus. *New York Times*.

general of the State of New York, which incorporated the Black Rock Forest Associates (otherwise to be known as the Black Rock Forest Consortium) under section 402 of the Not-for-Profit Corporation Law of the State of New York. The corporation was designated as being charitable, educational, promoting conservation and nature preservation, and benefiting the environment and wildlife. It was stated the Black Rock Forest Associates would accomplish the goals set forth by owning and operating or by allowing others to operate a real undeveloped and experimental forest for research, experimentation, education, recreation, field trips, scenic enjoyment, and by providing economic assistance to organizations promoting these causes. The names indicated as directors in this certificate of incorporation were William T. Golden, Helene Kaplan, and William Drayton Jr.[94]

Over the next two years discussions continued, and in the spring of 1987, Mr. Golden was prepared to move forward with the new Consortium. A meeting was held at the New York Academy of Sciences on April 21, 1987. There were several organizations represented and most notably were the number of K-12 school in attendance. The results of the meeting were tremendous, and quickly Mr. Golden received more letters of intent from institutions interested in membership than the expected 12. As a result, the membership was increased from 12 to 15 member organizations.[95]

Discussions continued over the next year. All parties involved in the transaction were now in agreement and Harvard University, the Golden Family Foundation, the Department of Environmental Conservation, and the Office of the Attorney General of the State of New York had all approved a draft agreement.

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[94] Black Rock Forest Associates, (1985, May 23). Certificate of Incorporation..
[95] Golden, W. (personal communications, June 3, 1987). Letter to potential Black Rock Forest Consortium Members.

On May 13, 1988 a meeting was held of all Consortium members at the New York Academy of Sciences. As a result of the meeting, the bylaws were adopted and the officers were elected. It was agreed that no payments would be made by Consortium members until after the transaction with Harvard was complete. The newly elected officers were William T. Golden (chairman), Philip Amirato (president and representative of Barnard College), Eric Holtzman (vice president and representative of Columbia), Leslie Berlowitz (vice president and representative of New York University), Dwight Kincaid (vice president and representative of Lehman College), Garnder Dunnan (vice president and representative of Dalton School), Talbert Spense (secretary and representative of NYAS), and William Kelly (treasurer and employee of Mr. Golden).

According to the Consortium's bylaws, membership would be open to any tax-exempt not-for-profit that is charitable, educational, or operates for the "mental or moral improvement."[96] Institutions seeking membership are required to do so in writing and obtain membership following the approval of the board. Each member institution chooses representatives, and at any time member institutions can withdraw their membership. Membership dues are set by the board of directors, who are elected and manage the affairs of the consortium. The bylaws also established the duties of the officers and established a requirement that an annual report be released.

The first meeting of the Consortiums executive committee was held on May 25, 1988. At that meeting, the need for a mission statement was discussed, and Dwight Kincaid suggested that the Forest could become a "World Class Field Science Research Station" and perhaps become part of the Organization of Biological Field Stations.[97]

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[96] Black Rock Forest Consortium. (personal communications, May 13, 1988). Minutes from Meeting.
[97] Kincaid, D. (personal communications, May 25, 1988). Minutes from Meeting.

Lucy Jones, of the Brooklyn Botanic Garden, discussed seeing the Forest used to advance in-service teacher training in environmental studies at both the primary and secondary levels. Frank Moretti, who would later become the President of the Consortium and a faculty member at Columbia University but who was at that time representing Dalton, presented ideas for using the Forest to develop curricula that would foster outdoor education. It was also suggested by the Consortium that a full-time education program coordinator be hired to oversee, design, and help implement educational programs at the Forest (unfortunately funds did not exist at that time for the position). It is important to note that the Consortium has been able to successfully accomplish many educational goals without a full-time education coordinator, a half time coordinator has been added to the Forest staff in recent years.

After receiving final approvals from the Supreme Court of the State of New York and the New York State Attorney General's Office, the purchase of the Forest by the Golden Family Foundation commenced. The purchase occurred on September 14, 1989, in the offices of Patterson, Berknap, Webb and Tyler in New York City. According to the contract of sale, the purchase was paid for by the Golden Family Foundation; however, the property passed immediately into the hands of the Black Rock Forest Preserve. Along with the Forest, all books maps and records, which were part of the files on the Forest, changed hands, as did the headquarters building. It was also required in the purchase agreement that the Forest continue to allow the Black Rock Fish and Game Club to use the premises for recreational purposes.

> In order to achieve the public purpose of preserving the Premises for the benefit of future generations, Grantee (the Preserve) covenants and agrees that the Premises are conveyed to the Grantee on the express condition that the Premises are to be used and maintained as an experimental forest and to carry on research, education

> and experimentation in silviculture and forest science which may include ecology, botany, biology, and geology (but not mining), and for water supply. Recreation, park and open space, and for no other purpose.[98]

The purchase agreement permitted the establishment of an institute to carry on research, experimentation, and education. It was stated that the Forest would be used for recreational purposes but that those activities would be limited to hiking, scenic enjoyment and other passive uses. It was agreed that the grantee would be responsible for maintaining roadways and trail and that trees could be cut and sold selectively but that no clear-cutting could occur. With foresight, the purchase agreement gave permission for the construction of a new building that would not exceed 35 feet in height and would not interfere with the basic nature or beauty of the land. Protecting the land from commercial development and or exploitation, it was stated that the property could only be sold or donated to a not-for-profit science and or cultural organizations such as the State of New York, the Palisades Interstate Park Commission, Scenic Hudson, Inc., American Museum of Natural History, Columbia University, and the like.

Following the purchase of the Forest by the Golden Family Foundation and immediate placement of the property in the hands of the Black Rock Forest Preserve, a lease agreement was established between the Black Rock Forest Preserve (owners of the Forest) and the Black Rock Forest Consortium (the not-for-profit scientific and educational organization). According to the terms of the lease agreement, the tenant, otherwise known as the Black Rock Forest Consortium, must pay $1 annually for the use of the premises. The lease is a long-term renewable lease for 20 years. The tenant is required to maintain the property and pay all taxes, salaries, insurance, operating and

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[98] Black Rock Forest Preserve. (1989, September 14). Purchase Agreement.

repair costs as well as any other bills. The property is to be used in accordance with the stipulations of the sale, which dictates that the property will be used soley for scientific research and educational studies. The Consortium is allowed, according to the lease agreement, to make minor changes to the property, including adding and maintaining roadways and cutting down trees as part of routine maintenance. The Consortium, however, is banned from mining or excessive harvesting of timber. The member institutions of the Consortium pay a nominal fee, which until recently was $8,000 annually. It increased for the first time in 1999, to approximately $10,000 annually.[99] [100] These membership fees help to run the Forest and pay the salaries of the Forest staff

The total purchase price of the Forest was $400,000 paid in full at the closing by an official bank check from the Bank of New York to Harvard University. An endowment was formed by contributions made by Harvard and also by Mr. William Golden. This money was placed in the Preserve and is used to help maintain the Forest, to provide loans to the Consortium, and to assist with the mission of the Forest by financing small grants that benefit education and research conducted by Consortium member institutions. An additional sum donated by the Golden Family Foundation to the Preserve, became part of a research fund (separate from the endowment), totaling $125,000, paid in five annual installments of $25,000. Harvard also made a contribution, of $125,000, to the Research Fund, also paid in five annual installments. The research fund was established and is overseen by the trustees of the Preserve to help fund research and educational activities conducted that are in keeping with the mission of the Consortium.

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[99] Golden, W. (personal interview, 2000).

[100] Dues are base on gradations that take into account institutional size and use of the Forest.

During the purchase, the endowment made by Ernest Stillman, estimated at $2.5 million, was transferred to the Harvard Forest at Petersham. The Stillman's sons were embittered by this transaction. John S. Stillman argued that the endowment should be transferred with the property. "I'm saddened at the way I consider Harvard has breached faith with my father and ignored the trust they accepted 40 years ago." He added noting the second-rate status that the Black Rock Forest had received, "Black Rock has always been a stepchild to Petersham."[101]

In response to John Stillman's complaints, Daniel Steiner, representing Harvard, told the *New York Times*, "We believe what we are doing is consistent with Dr. Stillman's gift."[102] Harvard argued that Dr. Stillman's will did not specify that the money remain with the Forest but that what was important is that the Forest remain a wilderness area used for scientific research.

During the later part of the discussions between Harvard and the Consortium the Mayor of Cornwall (the town that houses Black Rock) organized a group of business, civic, state, and local representative to investigate the proposed transaction. This group along with other state, community, and environmental groups were pleased with the purchase. The Natural Resources Defense Council as well as Scenic Hudson, two organizations formed during and because of the Consolidated Edison controversy, were satisfied with the outcome of the sale and transfer of the Forest to the hands of a unique and diverse consortium. The *New York Times* also applauded the purchase and the

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[101] Stillman, E. as quoted in Foderaro, L. (1989, August 25). Harvard will sell a forest, a legacy from an alumnus. *New York Times*.

[102] .Steiner, D. as qtd in Foderaro, L. (1989, August 25). Harvard will sell a forest, a legacy from an alumnus. *New York Times*.

formation of the new Consortium, although the paper did criticize Harvard's controversial decision to keep the endowment.[103]

Mr. Golden was quite optimistic for the future of Black Rock at the time of the closing. In his vision he saw the Forest used for research, scientific exploration, and education and was pleased that Dalton (a private K-12 school in NYC) had already begun using the Forest for tree-growth studies. Perhaps predicting the future and slow evolutionary path that the Consortium would take, he told the New York Times that a tree would be planted in Dr. Ernest Stillman's honor, adding that "We want a tree that will grow fast and live long, and those are somewhat in conflict."[104]

From Mr. Golden's initial talks with Daniel Steiner in early 1973 to the finalized purchase of the Forest and takeover by the Consortium, it was an event over 16 years in the making. Mr. Golden contends that it was not an undertaking that faced any real obstacles, "Just my own thoughtfulness and inertia."[105] According to Christie Van Kerhrberg, a secretary to Mr. Golden and secretary of the Consortium, his thoughtfulness and slow, calculated movement is part of what has made him such a success.

> This is the way Mr. Golden operates. He does not push ahead if there is a clear opposition. He waits for consensus; he waits to find the right mix of people and factors so that something can develop naturally. And it may take longer in its gestation period, but it will be borne a healthy entity as a result of this.... Not moving ahead with the actual purchase until it seemed that the right formula had been worked out and then going ahead with the consortium when it seemed as though the right group of institutions had expressed interest. This all developed in a very organic way.[106]

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[103] Williams, L. (1985, January, 15). Harvard amid opposition, plans to sell upstate forest given by alumnus. *New York Times*.
[104] Golden, W. as qtd in Foderaro, L. (1989, August 25). Harvard will sell a forest, a legacy from an alumnus. *New York Times*.
[105] Golden, W. (personal interview, 2000).
[106] Van Kehrberg, C. (personal interview, 2000).

Since the take over of the Forest by the Consortium, Black Rock has maintained a healthy relationship with the surrounding community. Although the Black Rock Forest is privately owned and operated, it has been committed since its inception to being a public resource. The Forest is open year- round to the general public during daylight hours, and visitors are welcome at no charge. Public visitors generally participate in recreational activities such as hiking, sightseeing, and biking. Keeping the landscape open to public visitations has helped to secure the Forest's role as a valuable community resource.

Consortium members have made great and frequent use of Black Rock. The Forest receives approximately 600 visits from Consortium members annually. These visits are represented by university faculty/post-doctoral/research staff, scientists, teachers involved in training, graduate/undergraduate students, and high school, middle school and elementary students and teachers.

Individuals involved in the formation of the Consortium are pleased with the dramatic progress that the Consortium has made since its inception. Numerous scientific publications, research reports, field courses, and curricular projects have been developed as a result of this landscape and the diverse Consortium that serves as its steward.[107]

The Black Rock Forest Consortium is a unique affiliation of varied institutions representing public and private colleges and universities, scientific and cultural institutions, and civic and private K-12 schools that for 15 years have collaborated to participate in activities that support ecological conservation, wildlife preservation, scientific research, and education. The make-up of the Consortium facilitates scientific/ research/ educational collaborations in a way that would not be possible without its

[107] A complete list of Forest publications, research reports, field courses and curricular projects is available through the Black Rock Forest headquarters blackrock@ldeo.columbia.edu.

diverse membership. The current list of Consortium member institutions includes, the American Museum of Natural History, Barnard College, Brooklyn Botanic Garden, Browning School, Calhoun School, Columbia University, Cornwall Central School District, Dalton School, Friends Seminary, Marine Biological Laboratory at Woods Hole-Ecosystems Center, New York-New Jersey Trail Conference, New York University, Newburg Enlarged City School District, PS 176, the School at Columbia University, and the Storm King School.[108]

The concept of a consortium of institutions is not entirely unique; however, the Black Rock Forest Consortium does have several outstanding features that together make it an exemplary and unusual organization. The Consortium's member institutions are highly unusual in not just their prestige, resources, and intellectual weight but also the extraordinary representation of scientific foundations, cultural organizations, and blend of educational institutions representing all levels of academia while servicing many different types of populations.

When Forest staffers and Consortium members were asked as part of my investigation the greatest strengths of the Consortium the overwhelming responses were 1) the diverse membership of the Consortium, 2) the multiplicity of ideas that have been developed to make use of the Forest, 3) the expansion of resources that Consortium membership provides, and 4) the dedication of Forest staffers and Consortium members. They point to the fact that member organizations have been brought together to collaborate with the goal of creating new projects. According to Consortium board member and daughter of Consortium founder William Golden, the work of the

[108] Black Rock Forest Consortium membership list current as of 2003.

Consortium would not be possible if it wasn't for the diverse membership and dedicated individuals involved.

> The greatest strength of the Consortium is that it makes it possible for institutions that would not use the Forest full time, or have the resources to do so, to run field-based educational and research programs... Without this opportunity for institutions to share the operation and use of the Forest, thousands of students and scientists would not have access to this wonderful resource. Further, the importance of collaboration between K-12 educators and scientific researchers is increasingly recognized by funding organizations.[109]

Summary

The greater Hudson River area is one of our national treasures and the Black Rock Forest is one of America's more stunning landscapes, a landscape that is representative of the once pristine nature of the surrounding region. As a result, the Black Rock Forest is of tremendous historical, geological, ecological, recreational, educational, and scientific significance.

Although originally intended to become the home of wealthy banker James Stillman, it was his son Ernest whose love of conservation caused him to embrace the then new and revolutionary practice of sustainable forestry. Due to Ernest Stillman's tremendous foresight, the property was protected from development and bequeathed to Harvard University, along with a generous endowment, in order to establish an experimental and protected forest.

When Black Rock was threatened to be degraded and developed by Consolidated Edison, the people of the surrounding community banded together, battling tirelessly for over 17 years. In the end, Con-Ed was defeated and the stage was set for communities to take action to protect their surrounding environment. This battle received national

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[109] Golden, S. (personal communications, 2004).

attention and helped to spark America's modern environmental movement. The effects of this struggle continue today proving its deep and long-lasting effects.

Harvard University, which received the Black Rock Forest following Ernest Stillman's death, never fully took advantage of the scientific and educational possibilities. Seeking advice for the future of the Forest, Daniel Steiner, who was then chief council of Harvard University, contacted his friend Mr. William Golden, a noted philanthropist and supporter of the scientific community and then-Chairman of the American Museum of Natural History and the American Association for the Advancement of Science. After visiting the Forest and meeting with local environmentalists, as well as other concerned parties, Mr. Golden outlined his idea to have Harvard sell the Forest to a group of science, educational and cultural organizations. Over time, visions were crystallized, meetings were held, legal issues were addressed, and a unusual organization was formed.

The Black Rock Forest Consortium is a unique organization of diverse institutions that for 15 years have collaborated to participate in activities that support ecological conservation, wildlife preservation, scientific research, and education. The concept of a syndicate of institutions is not entirely unique; however, the Black Rock Forest Consortium does have several outstanding features that together make it an exemplary and unusual organization. The Consortium's member institutions are highly atypical in not just their prestige, resources, and intellectual weight but also the extraordinary representation of scientific institutions, cultural organizations, and blend of educational institutions representing all levels of academia while servicing many different types of populations.

The Black Rock Forest Consortium has made tremendous contributions to the fields of education and scientific research and has demonstrated the value of collaborative partnerships between higher education, public and private K-12 schools, cultural organizations, and the scientific community.

Chapter II

THE BLACK ROCK CONSORTIUM ENHANCING EDUCATION

Since its formation in 1989, the Consortium and its activities have consistently expanded becoming increasingly more prolific. Individuals from member institutions have conducted numerous research investigations resulting in a significant volume of papers and publications.[110] Papers and publications have covered such varied topics as forest physiology, microbial and invertebrate biodiversity, paleoecology, geology, history, mammal behavior, tree ring analysis, animal behaviorism, ecology and conservation, canopy studies, predator/ prey relationships, flora and fauna, stream and brook analysis, insects, earth science education, and indigenous vegetation.

As a result of Black Rock's efforts, the Forest has received much positive attention for its role as a field station, an information network, and an intellectual resource that works to bridge the gap between scientific practice and education by increasing exposure to the scientific process.

The Consortium recognizes the importance of environmental studies and it has never wavered from its commitment to enhance education, working on teacher training, experimental education, curriculum development and delivery, field trips and other activities, access to data, and increasing exposure to scientific practice through hands-on projects and by expanding access to the work of actual practicing scientists.

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[110] A selected bibliography of publications is included in Appendix B.

Forest staff frequently works with Consortium member educators in the development of curricula and offering of courses. Often the curricula developed are circulated among and enhanced by educators from the other Consortium member institutions. Because of the diverse interests represented by the Consortium members, the range of curricula and courses that have emerged are especially varied. In addition to the expected ecological, geological, chemical, and biological studies curricula; multidisciplinary classes covering American history have been conducted, as well as mathematics, photography, and writing. Some of the more noteworthy curricular topics that have been developed include; watershed explorations, tree identification and ring measurement, life cycles, bird migration, habitats, geology and soils, species diversity, climate, global warming, and forest ecosystems studies. Most of these lessons encourage the students to act as scientists as they participate in include hands-on experiments, with many taking advantage of digital technologies such as global positioning system units (GPS), Geographic Information System (GIS) mapping, database technologies, radio telemetry environmental monitoring sensors, and remote infrared-trigger cameras. According the Forest website, "The Consortium provides a center for research and teaching at all levels and an information network linking students, researchers, teachers, administrators, and institutions."[111]

The Forest is a landscape that although is located a mere two hours from New York City, is bucolic, providing visitors with a sense that they have become immersed in a landscape that exists deep within our nation's most remote reaches. As a result, Black Rock is a haven and retreat for those that wish to depart from the hustle and bustle of the contemporary world. Therefore, it comes as no surprise, that the Forest is frequently

[111] Black Rock Forest Website. Retrieved January 1998, from http://www.blackrockforest.org.

utilized by not only students and teachers studying and developing science curricula but also by groups of educators and learners interested in team building exercises, faculty retreats, professional development, physical activities and adventures, and leadership programs.

Currently, more than half of the annual visits to Black Rock are by groups of learners and educators from the public and private K-12 and university institutions that are members of the Consortium. According to 2001 Forest statistics over 600 trips were made to the Black Rock that year ranging in size from 1 to 100 visitors. There were 300 class trips with 105 being from elementary schools, 40 from middle schools, 126 from high schools, and 30 from undergraduate and graduate institutions. Another 225 visits were made by faculty as well as undergraduate, graduate, and post-graduate students conducting research projects. Finally, 120 trips were made to the Forest by faculty and staff members for training, preparation, and other retreats.

Such groups as the Junior Academy of the New York Academy of Sciences, the Ecology Club from the American Museum of Natural History, and teachers and students that are participants in programs offered by groups like the Institute for Urban Education at Barnard College have all visited Black Rock with the purpose of encouraging education in some form or another. Former Interim-Forest Director, Peter Bower, notes:

> The Forest's unique combination of scientific research and education at all levels makes it an ideal setting for teacher training and curriculum development, because it offer educators the opportunity to bring real research activities into their teaching and curricula.[112]

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[112] Bower, P. (2000, Fall). Forest Directors Report. *Black Rock Forest Newsletter*.

At the undergraduate and graduate college level there are numerous courses offered with names such as Plant Biology, Field Methods in Environmental Science, Entomology, Whole Earth Science, Life System, Elements in Ecology, and Forests and Climate Change. Often science majors use Black Rock for their undergraduate or graduate thesis work. In many instances, students work under a faculty member at their academic institution assisting in research studies.

Over the years, colleges and universities have conducted numerous research studies and utilized Black Rock as an open lab to enhance courses. They have also conducted teacher-training, team-building exercises, and worked with K-12 students and teachers. In many cases, their activities have helped to bring additional funds and resources to Black Rock.

Science and cultural institutions such as the American Museum of Natural History and the Brooklyn Botanical Gardens have used Black Rock for research but have also taken advantage of the educational benefits of the Forest to offer courses, field trips, lectures, summer camps, staff development activities, and workshops. According to Myles Gordon, Director of Education at the American Museum of Natural History:

> The Black Rock Forest is a terrific complement to the Museum's resources... The Forest and its staff provide a wonderful setting where students, particularly those from the city, can experience nature, learn and practice field research skills, and equally importantly, work with one another and have a great time. Together the Forest and the Museum make powerful partners to support tomorrow's scientists, citizens, and stewards of the planet.[113]

Forest staff members and individuals who have been sent to the Forest from such organizations as Americorps actively work on the development of curricula, often

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[113] Myles, G.. (1999, Spring). *Black Rock Forest Newsletter*.

collaborating with teachers at various levels of education. As a result, new curricula are being designed and made available every day covering a myriad of academic areas. Most curricula involve hands on activities and visits to the Forest, while others take advantage of digital technologies to allow learners to experience the Forest from remote locations.

In order to facilitate learning the Forest makes a number of these curricular resources available. The Forest has a collection of 35 Master Lessons available that include ready-to-use curricula. They offer a collection of workshops, which include lectures followed by guided tours. They have numerous teacher training manuals available that cover a variety of subject matter. For example, the Living Laboratory Educational Series produced by the Consortium provides guidance to teachers to help them teach at the Forest offering suggestions for preparation, activities, and readings. Each volume in the series includes a brief history of the Forest, maps, directions, rules, lesson plans, outdoor activities, and other exercises to bring back to the classroom for further exploration. The series covers such topics as forest habitats, geology and soils, water quality, and ecological succession. The series is designed for middle school students but can be modified to be utilized by educators teaching at the high school or college level.

To enhance learning experiences at the Forest staffers make a wide array of equipment and resources available to teachers and students. These resources include field equipment, such as, sampling and measuring supplies for streams, ponds, soil, air, and trees; nets and traps for catching small insects, fish, turtles, and small mammals; GPS units; remote cameras; field guides; plant presses; spotting scopes and hand lenses; clipboards; backpacks; maps; compasses; camping supplies; and first aid kits. Teaching

supplies include; skins, skulls, and skeletons; and a herbararium. Lab equipment includes; a tree ring analysis station with cores and slabs; soil sieves; water chemistry meters; dissecting kits; tanks and terrariums; microscopes; beakers and test tubes; ovens, refrigerators, and freezers; and distilled water and ice. Classrooms are equipped with computers; printers; overhead and digital projectors; VCR's and videotapes; a library with books, maps, and journals; Internet access; and access to the Forest's database.[114]

K-12 schools located in close proximity to the Forest such as the Storm King School, Newburg Enlarged City School District, and Cornwall Central School District have used Black Rock extensively as an outdoor classroom, as a cite for leadership training, for conducting experiments, and for outdoor activities. According to Scott Smith of the Storm King School, a private K-12 school and Consortium member:

> Our after school program has hiked and mountain biked to the heights of Black Rock developing outdoor skills, exploring, exampling natural history, and playing after a long day in the classroom. These same students have found a way to give something back to the Forest by being involved in periodic Forest clean ups.[115]

The K-12 member institutions located at some distance from the Forest (primarily in New York City) have also been proactive in their utilization of the Forest. They have developed an array of curriculum and merged visits to Black Rock with classroom learning. They conduct overnight trips to encourage in-depth learning and have also been profitable in their use of technology.

John Brady, Forest Manager, pioneered the earliest educational programs at Black Rock prior to the take over of the Forest by the Consortium. Serving early on as an

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[114] Black Rock Forest Consortium. (2003, Winter). Education. *Black Rock Forest Newsletter.*
[115] Smith, S. (1993, Winter). *Black Rock Forest Newsletter.*

assistant, John Brady has been employed by the Forest since Harvard's tenure as owners. Mr. Brady had a long relationship with the Museum of the Hudson Highlands as a volunteer, where he was actively leading groups of kids through Black Rock for such activities as tree identification and animal watching. Overtime workshops were developed in conjunction with the Museum that incorporated lectures on animals and habitats followed by visits to particular Forest locations that included hands-on activities. The series of workshops were designed for students ages 7-18 and is intended to help educators see the potential of the Forest.

Although not part of his job description, John Brady's education in forestry and wildlife inspired him to begin studying the deer population of the Forest in 1984, which involves tracking herds, examining carcasses, and measuring acorn production. As a result, Black Rock has become a certified deer station and much of Brady's work has been incorporated into curriculum. He has created curriculum with Peter Bower of Barnard College for students to study trends in deer population. For example, today fourth grade students from the Dalton School in New York City look at the correlations between deer density and acorn production. According to John Brady, "the whole idea is to stimulate teachers."[116]

The Black Rock Forest Consortium has emerged over the years as an educational resource that houses teacher-training, serves as an open space classroom, extends outdoor education, supports research and bio-diversity studies, and helps to bridge the gaps between science and education by encouraging students to participate in hands-on activities that allow them to take on the role of a real working scientist. According to Forest Director, Dr. William Shuster:

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[116] Brady, J. (personal interview, 2000).

> The Black Rock Forest Consortium was formed in 1989 to further the missions of a diverse group of academic institutions. In addition to rigorous research programs at many of these, each has a major educational mission. Among the unusual attributes of the Consortium is the breadth of the audience of its collective membership, from kindergartners through graduate students and beyond... the Consortium's programs centered around the Black Rock Forest have value to offer to all ages.[117]

Approximately 7,000 students visit the Forest annually representing all levels of education. There are four colleges and universities, nine K-12 educational institutions, and four science and cultural institutions that comprise the Black Rock Forest Consortium. These institutions have utilized the Forest for a myriad of educational purposes, taking multidisciplinary approaches, and often collaborating to extend the benefits of services. Educational projects have been developed by individuals at Consortium member institutions often in conjunction with Forest staffers. Many have also received grant money to assist in their formation. Currently, the Forest employees a part time Education Coordinator to facilitate and assist in the continued growth of the Forest as a source of erudition.

In 1995, the Consortium introduced a new mission statement that provides a vision for the Forest as "A Center for Research and Education." According to Forest Director, Dr. Shuster, "It is apparent that a harmonious mix of these two often divergent endeavors [research and education] is a common goal, and an area in which our organization is making new inroads."[118]

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[117] Shuster, W. (1995, Winter). Forest directors report. *Black Rock Forest Newsletter.*
[118] Shuster, W. (1995, Winter). Forest directors report. *Black Rock Forest Newsletter.*

Black Rock Forest Consortium Mission Statement

A Center for Research and Education

- Promote scientific study of the organisms, environment, and interacting processes operating within natural systems.
- Foster research to access the environmental effects of human activities upon the integrity and stability of the biosphere.
- Build a community for scientists and educators among the member institutions with the goal that educational programs be based in real science and have as a part of its purpose the support of vital educational programs.
- Use the Forest as a model site for learning basic scientific principles, emphasizing an experimental approach and fostering investigative and problem solving skills.

An Information Network[119]

- Maintain at the Forest a local area network with remote sensors capturing environmental data and distributing it through wide are connections to students and scientists.
- Construct linkages with other institutions by means of the national information infrastructure to both collect and disseminate data for educational and scientific use.

Ecosystem Management

- Provide a model of careful resource management directed at preserving the Forest's biological diversity and its wild and pristine nature.
- Use scientific principles and an evolving scientific database to manage the Forest as an interacting part of a larger natural system.
- Serve as a public resource for leisure time activities, appropriate to the Forest's health.
- Work with the surrounding community to share information, build natural partnerships, and provide leadership on the integrated management of natural resources.
- Design and manage facilities in full cognizance of green architectural principles.

1995

Figure 4: Black Rock Forest Consortium Mission Statement

[119] The term "Information Network" refers to the Consortium's ongoing efforts to use digital technologies to promote the wide access and availability of historical and current research data, archival publications, ongoing research projects, collaborative organizations, and scientific databases.

The Consortium has helped to give birth to many educational projects over the years that have been created using a variety of means. Most have involved a collaboration between consortium member groups with the assistance of Forest staffers and many have received grant funding. Although these projects are quite varied, they share a common theme of providing greater access to the scientific process to educators and learners. These projects succeed in linking teaching and learning to scientific practice by engaging teachers and learners in hands-on activities that involve real data collected at a familiar landscape that is a dynamic living system. Educators and learners exposed to Consortium created projects can participate in teaching and learning exercises that mirror the activities of actual working scientists. In this vein, Consortium members have introduced diverse teacher- training, curricular, and other educational experiences that help take the study of science outside of the classroom and the textbook and place the scientific process square in peoples laps.

Educational Projects

The make-up of the Consortium with its diverse membership base of K-12 schools, universities, and science and cultural centers has encouraged the fusion of ideas. In this regard, the educational projects that have been developed by the Consortium mark a synthesis of concepts; such as, hands-on experimentation, project-based learning activities, the understanding of systems dynamics, the building of research and evaluation skills, the development of student-centered curricula, and role playing, all of which are currently considered a part of progressive constructivist learning. Following is a summary

of some of the noteworthy curricular projects that have been created by the Black Rock Forest Consortium and its member institutions.

The Integrating Scientific Research with Middle School Education: Newburg Schools/ Black Rock Forest Water Monitoring Project began in 1992. It involves students at the nearby public Newburg City School District, who created the project with the assistance of Forest staffers, participating in a hands-on project that allows learners to take part in scientific research that is part of a real ongoing scientific experiment. Students participating in this program learn over three years how to use scientific equipment and gather and analyze real data. They take part in the weekly sampling of water and acid rain. They develop an understanding of a natural system and human impact on the system. Overtime students are able to make real testable predictions and test the accuracy of their predictions. A major benefit of the Water Monitoring Project is that it helps students connect with and develop an understanding and appreciation of the work of real scientists.

Training Urban Teachers to Teach Ecology: The Investigation Colloquium Method (ICM) for Mathematics and Science Education is a program lead by the Dalton School a private school located in New York City. The program uses the Investigative Colloquium Method developed at the Dalton School in the 1950's that involves hands-on investigations that include data gathering, experimentation, and discourse, to teach students key concepts in math and science. During the training sessions held at Black Rock and facilitated by Dalton in collaboration with the New York University School of Education, New York City public school teachers are trained in the use of the ICM pedagogical approach and assisted in the development and implementation of hands-on

science curricula. The ICM Project was funded by a variety of sources including U.S. Department of Education, Secretary's Discretionary Fund; the Fan Fox and Leslie R. Samuels Foundation, Inc.; the Altman Foundation; the Carnegie Corporation of New York; the Dalton School's Institutional Community Fund; Avon Products, Inc.; and the New York City Board of Education.

Brookies at Black Rock is a project that was stimulated by Trout Unlimited's Trout in the Classroom (www.troutintheclassroom.org). It involves Black Rock developing a trout breeding program where two 180 gallon tanks, one filled with ground water and the other filled with stream water, are housed in the Center for Science and Education. The tanks contain Brook Trout (Salvelinius Fontinalis) a native New York State variety of trout commonly found in the Adirondack region of upstate New York where they breed in late winter. Participating students learn trout behavior, living conditions, and anatomy. They are exposed to the fertilization process as well as the 37-day development of the offspring from fry to fingerling. Throughout the development of the trout the students make periodic mortality counts, study water characteristics, and graph results of their findings. Six months after fertilization, the young trout are released into surrounding streams. This project is geared towards students fourth grade and beyond and allows learners to engage in real hands-on scientific experimentation. Currently, the Browning School (a Consortium member institution) has received a Black Rock Forest Research and Education Grant to develop and implement this program at their school.

Building Watershed Bridges is a program funded by the Youth Resource Development Corporation AmeriCorps Program, U.S. Environmental Protection Agency

Region II, and New York State Council on the Arts. Created with the assistance of Forest staffers and AmeriCorps volunteers, it has involved the development of curriculum, a teacher-training manual, analytical activities, and Forest immersion workshops that focus on aquatics, wetlands, streams, the importance of clean water, and the understanding of watersheds. It has resulted in the development of partnerships with individuals from the local community as well as several Consortium member institutions and as its name notes serves to build bridges that link scientific practice to teaching and learning.

The Dalton School runs a day in the Forest program. The New York City private school brings students to the Forest for a day of water sampling, hiking, tree measuring, studying forest ecology, and learning about Black Rock's human and geological history. The data collected by the students is entered into spreadsheet software where students analyze trends, reconstruct the Forest's history and the impact humans have had on the Forest over time, and make predictions for the Forest's future. As a result of their work, students are able to discuss the important societal and ethical issue of global warming as they have examined first hand the impact of human infringement on ecosystems through their time spent immersed as scientists at Black Rock.

The Science Teacher Environmental Education Program (STEEP) is run through the Center For Environmental Research and Education (CERC) of Columbia University. STEEP participants are K-12 educators, especially teachers of grades 6-12 and the curriculum is tied to science education standards for New York and New Jersey. During this summer program where participants are able to earn graduate credits, teachers learn the fundamentals of environmental ecology through the immersion and examination of a living landscape, develop the skills to bring conservation biology into their classroom,

and how field trips and outdoor education can be used to support local and national standards for science education. This four week course focuses on the lower Hudson River Valley taking advantage of the Black Rock Forest resource, the New York Botanical Garden, as well as visits to parks, preserves, and museums. It involves participating educators developing curriculum as a result of interaction and collaboration with scientists and environmental educators at Columbia University, the Black Rock Forest, and other conservation organizations.

Biodiversity of Spiders is a project that has been created out of the real scientific research of American Museum of Natural History scientists who have been studying the arachnids of Black Rock for some time. This project has resulted in the creation of a dynamic interactive spider section of the American Museum of Natural History website (www.amnh.org). The site includes photos and drawings, definitions, as well as a clickable model. Educators are encouraged to use the online resource in conjunction with a visit to the physical Forest where learners can examine real specimens and the data collected by professional scientists from one of the nation's leading museum of science and culture.

The Amphibian Project at Cornwall Elementary School involves fifth grade students at this local elementary school acting as scientists as they examine how environmental conditions impact salamanders at the Black Rock Forest. The students begin by exploring archival data found in the library and on the Internet. With newly acquired background information the students enter the field where they use scientific equipment to measure soil and water pH; gauge air, soil and water temperature; and collect, identify, and release salamanders. Information acquired is recorded and cataloged

in log-books, analyzed; visually captured with the assistance of digital photography, and expressed in Excel spreadsheets and Power Point presentations. The students visit the Forest on numerous occasions in groups with students being assigned jobs as data/recorder/writer, equipment manager, photographer, facilitator, and species identifier. During each trip to the Forest the students switch roles so that each student has the opportunity to fulfill the different jobs required in this hands-on scientific experiment. In the future the school plans to expand the Amphibian project to include other grades and so that it can become a real longitudinal scientific study.

The Institute for Urban Education based out of Barnard College ran a program that brought undergraduate education majors from sixteen northeastern colleges such as Brown, Vassar, Barnard, and Yale to the Forest where they were provided with experience working with middle school students from New York's inner city. It began in 1993 with the assistance of a $3 million dollar grant from the DeWitt Wallace-Readers Digest Fund. It involved participating undergraduates spending one spring semester teaching in an underserved New York City public school then for three weeks during the summer the undergraduates, some of their teachers, education faculty from participating colleges, and middle school students studied hands-on ecology and science at Black Rock. One of the goals of this project was to challenge future educators by providing them a unique setting outside of the traditional classroom in which they could practice dynamic student centered teaching techniques. This project resulted in the design and release of computerized Forest ecology curriculum that is made available to New York City public schools thanks to a grant received from Bell Atlantic. The curricular material can be located at (http://www.barnard.edu/iue/forestcurricula/fchome.htm).

The School in the Forest program is the newest educational initiative to occur at Black Rock. The School in the Forest program began during the 2002-2003 academic year and started as a three-year pilot program. The program involves partnerships between the Consortium and selected New York City public schools. The selected schools receive full Consortium memberships. During the program participating middle schools will be involved in teacher-training that includes lesson plans and materials that help satisfy New York State learning standards for math, science and technology; classroom visits by Forest educators; day trips to the Forest during the first year; two overnight class trips to the Forest each year after the first year; participation in real ongoing scientific research projects that include electronic data collection and experiments from their remote-locations; as well as classroom visits by actual working scientists. The School in the Forest Program is largely being funded by grant money received from the New York Community Trust.

The breadth of educational programs that are sponsored by Consortium member institutions are varied. Although just a sampling was mentioned above, additional programs occur at the Forest throughout the year run through such organizations as the Brooklyn Botanic Gardens, the American Museum of Natural History, the Newburg Enlarged City School District, and New York University. All of these projects help to encourage greater access to and participation in the practice and analysis of scientific research.

The Consortium has been quite prolific in its efforts to promote conservation, research, science, and education; however, up until recently their biggest obstacle was the lack of adequate resources and facilities. Although the Forest had been able to make great

strides regardless of this shortcoming, they predicted early on that in order to prosper and fulfill their mission, a laboratory space for science and teaching was needed. The need for new facilities was discussed by the Consortium in meetings as early as 1990 and as the Consortium and activities surrounding the Forest continued to grow the need for expanded facilities became increasingly more evident. Even at that early date, Forest staffers and Consortium members recognized that limited facilities hindered their ability to offer expanded resources to scientists and learners, and more importantly in their efforts to create greater linkages between scientific practice and education by encouraging teachers and learners to participate in the scientific process by interacting with the work of actual scientists.

Green and Smart the Black Rock Forest New Center for Science and Education

A new facility known as the 'Green and Smart' Center for Science and Technology has opened and is designed to enhance the practice of the Forest. It has replaced the previous 2,000 square foot outdated prefabricated structure, which for years housed the Forests offices, storage, lab space, and housing. As a result, the old headquarters has since been converted in a 16-bed dormitory that is used by visiting researchers, teachers, and students.

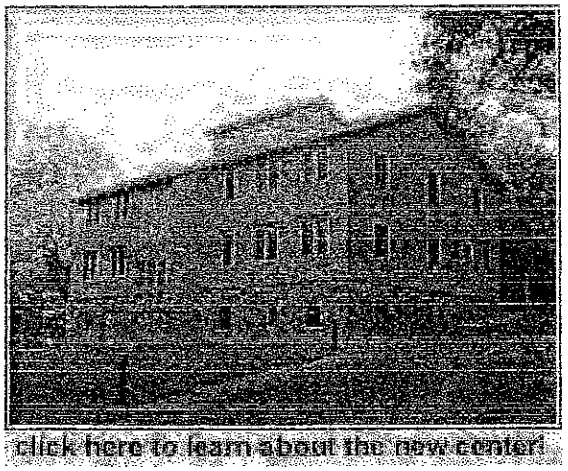

Figure 5: Photograph of the New Center, courtesy of the Black Rock Forest Consortium.

The Black Rock Forest Center for Science and Education was designed by the architecture firm of Fox and Fowle, located in New York City. Fox and Fowle is an environmentally responsible design firm world famous for having built the new Conde Nast and the Reuter's buildings in New York City's famed Times Square, in addition to numerous urban planning, residential design, reuse, transportation, cultural, educational, and international projects.[120] According to the firm:

> Fox & Fowle has maintained a commitment to environmentally responsible design and to the integration of the principles of sustainable architecture into every aspect of our professional practice. We have always strived to have our projects be environmental "good neighbors" that integrate energy conservation measures utilize sustainable materials and processes, and maximize natural light, and indoor air quality.[121]

Green architectural design is a rather new addition to our vernacular and one that is increasingly gaining interest. Currently, Fox and Fowle is one of a host of architectural firms that are pioneering the design and construction of green buildings. According to Fox & Fowle there are several key characteristics involved with the design and

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[120] For more information on Fox and Fowle visit Http://www.foxfowle.com or call 212-627-1700

[121] Fox & Fowle Architects. *Company profile.* Retrieved (2002). from http://www.foxfowle.com/foxfowle.htm

construction of environmentally conscious green buildings. Environmentally conscious buildings are concerned with limiting consumption. As a result, they are built to decrease energy use through design ideas such as the use of renewable energy resources, and the use of recycled materials. Environmentally responsible buildings seek to cooperate rather than dominate the environment by taking advantage of benefits and variations inherent in natural landscapes. The materials used in the construction of green buildings are selected to minimize negative environmental impact. Materials are chosen because they are environmentally friendly in use and during their manufacture.[122]

The Black Rock Forest's new center is noted for being "Green and Smart". The green features to this building have allowed it to serve as an archetype for the implementation of ecologically sustainable design principles. According to the Black Rock Forest website:

> Careful planning has allowed for the construction of a building that will address the needs of researchers and educators, and at the same time not compromise the environmental ethic that is the foundation of Black Rock's development.[123]

The new center has been designed to serve as a model for efficiency that makes all effort to minimize energy consumption and environmental impact. Computer modeling based on energy consumption assisted throughout the design process.[124] The selection of a site was particularly important to the green design of the building with architects choosing a site with little biodiversity, previously existing roads, and easy access to the entirety of the Forest. The Center was built on the site of a former farm,

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[122] Fox & Fowle Architects. *Green architecture.* Retrieved (2003). from http://www.foxfowle.com/foxfowle.htm.

[123] Black Rock Forest Consortium. *Black Rock Center for Science and Education.* Retrieved 2001 from http://www.blackrockforest.org/

[124] "The fine-tuning of the building design was aided by a computer model energy consumption analysis." Fox & Fowle Architects. *Company profile.* Retrieved (2002). from http://www.foxfowle.com/foxfowle.htm

where trees had previously been cleared and humans had already had an impact. The construction of the building also showed foresight by utilizing natural wood and stone from the Forest, the usage of durable long life materials, the minimization of post construction waste, the recycling of construction leftovers, using materials with low levels of toxicity, avoiding bedrock by incorporating the building into the existing slope, and the planting new flora and fauna that are preexisting to the Forest.

The rectangular shape of the building, which faces due south allows for passive solar heating. Stone masonry helps to absorb and store heat in the winter as well as cool the building in the summer months. Heat flow in the winter and cool breezes in the summer are assisted in circulation by ducts, vents, windows, a roof monitor, and fans. Windows of a precise size and type (low-e argon filled glazing) were installed to assist in a high level of natural light transmittance and thermal efficiency. Overhangs above the windows help to lessen the sunlight in the summer. The centrally located atrium with skylight helps to bring natural light and ventilation to the center of the building. Tight insulation is used to assist efficiency. A large foyer at the buildings entrance is designed to decrease heat transfer from outdoors to indoors. Most noteworthy, the center has a geo-thermal heating and cooling system that takes advantage of the natural near constant temperature of the environment located well below ground of the center. The geo-thermal heating and cooling system brings air from above downward where it returns back either warmed or cooled.[125] [126]

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[125] Black Rock Forest Consortium. *Green and smart components of the Black Rock Forest center for science and education.* Unpublished Handout.

[126] For more information on the construction and design of the Black Rock Forest Center for Science and Education visit http://www.blackrockforest.org or contact blackrock@ldeo.columbia.edu or visit Fox & Fowle Architects. http://www.foxfowle.com/foxfowle.htm.

Black Rock's staff is aggressive in its recycling efforts. The staff recycles paper, plastic, and metals whenever possible. The building also includes its own built in waste reducing and recycling elements such as water-conserving fixtures and a self-composting toilet system that greatly reduces the septic output.[127] According to the Consortium, "The Black Rock Center for Science and Education combines modern day technology with environmental ideology."[128] Because the building is considered innovative, it serves as a living model in green design. Its examination is of interest to educators, learners, citizens, policy makers, builders, and scientists alike. According to the Fox & Fowle architectural firm, designers of the building; The Center's site sensitive design, building form, material use and energy consumption management make it a model sustainable facility.[129]

Keeping with the Forest's mission to serve as an 'information network' the new structure has also been designed to be a smart building. The label smart building refers to structures that take advantage of modern technologies to facilitate productivity, communications, collaborations, scientific research, and education.

The Forest's New Center houses the base station that acts as a receptor for the information gathered from environmental monitoring stations located throughout the Forest's landscape. A current grant project seeks to significantly enhance this base station. Information collected by the sensors is transmitted to the center via radio telemetry.[130] The data collected by the sensors is stored in the Forest's data server and is

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[127] Black Rock Forest Consortium. *Green and smart components of the Black Rock Forest center for science and education.* Unpublished Handout..

[128] Black Rock Forest Consortium. *Black Rock Center for science and education.* Retrieved 2002 from http://www.blackrockforest.org/

[129] Fox & Fowle Architects. *Company profile.* Retrieved (2002). from http://www.foxfowle.com/foxfowle.htm

[130] Shuster, W. (2002). *Modernization and expansion of the ecosystem monitoring network for scientists, students and educators at the Black Rock Forest field station.* Unpublished Proposal. Cornwall, NY: Black Rock Forest Consortium

available from any of the Center's computer terminals. In addition, to the sensors located throughout the Forest's landscape the Center has its own monitoring sensor station. These sensors monitor the building and the environmental conditions within and around the building. Since the sensors record real data that is studied by working scientists the ability for students to access the data at the Center's computer terminals allows learners to examine real scientific research practice where and when it is happening.

Since its opening, the Consortium has been diligently tracking the Centers air temperature, water usage, and energy consumption on an hourly basis. Students are able to access this information, which demonstrates that the building uses approximately 57% less energy than a building of comparable size following state energy conservation codes and that the Center falls well below projected heating and cooling costs. This helps the Center in its goal to serve as a model for green design principles as well as promote the understanding of systems dynamics because the Center is a working system. In this vein, it can provide learners with an experience in which they are immersed in the system they are investigating.

The New Center holds the Consortium's database of research papers and publications. Papers and publications as well as research data collected at Black Rock since the time of Ernest Stillman is available at the Center. Gradually the Consortium is working to make more and more of the Forest's archives available in a digital format because the investigation of archival data is of historical interest and significance.

A computer network has been established as well as computer labs and ports so that laptops can be brought into the Center and hooked up to the network. The structure includes wet and dry laboratories, a conference room, a data management center, a GIS

center, offices available to visiting researchers, offices for Forest administration, classrooms, and a caretaker's apartment. Lab equipment includes; a tree ring analysis station with cores and slabs; soil sieves; water chemistry meters; dissecting kits; tanks and terrariums; microscopes; beakers and test tubes; ovens, refrigerators, and freezers; and distilled water and ice. Lecture rooms take advantage of the benefits of technology to support teleconferencing, video, and computer projection. The lecture rooms include computers; printers; overhead and digital projectors; VCR's and videotapes; a library with books, maps, and journals; Internet access; and access to the Forest's database. A high-speed connection to the Internet helps to facilitate the communications, education, collaboration, and the transmission of data from the Forest. Computer and network access has been installed in all rooms, with multi-media and video conferencing capacity.

The new computer labs and computer network are designed help the Forest in its efforts to foster access to scientific practice. The computer labs and equipment allow teachers and learners to gain experience with real scientific research and data materials. It encourages greater access to data collection tools, actual data that have been collected, modeling and data analysis software, all of which are valuable tools that play an integral role in facilitating the work of professional scientists.

An additional goal that the New Center facilitates is making scientific knowledge increasingly more accessible to individual throughout the scientific community. Having a central place for the collection and transmission of the Forest sensor collected data assists the Forest in its efforts to collaborate with similar institutions located at geographic distances and also to become part of a global network of environmental monitoring systems.

The building of the new center is designed to push the mission of the Forest into the future. The benefits are designed to have a long lasting impact on the Forest's productivity as it helps to facilitate scientific research and education. Having these facilities not only helps to sustain ongoing projects but also provides extended resources to encourage further projects. By encouraging scientists and educators to use the Forest facilities it is designed to allow for greater levels of collaboration among Consortium institutions.

Since its opening in 1999 the Center has expanded productivity at the Forest. The new Center has allowed the Forest to host greater numbers of people simultaneously, as a result, starting in 2000 the Consortium introduced the annual Black Rock Forest Research Symposium, an academic conference where researchers and educators present their papers and discoveries. A publication of abstracts of symposium presentations are made available by the Forest.

Undoubtedly the new Center will continue to have an impact on the future of not just the Forest and the Consortium but also as it serves as an exemplar and inspiration to other groups, for learners, and for the construction of other green and smart buildings. The New Center will continue to improve as the Forest improves the Center's laboratory space, access to computer modeling software, and access to data. The Center has created increased demand for overnight visits. Although the old headquarters has been converted into a 16-bed dormitory, this has not been sufficient to meet demand. As a result, a new 6000-ft2 structure was built adjacent to the New Center that can accommodate up to 50 visitors and is connected to the Forest's network. Opening in the spring of 2004, the new dormitory has been designed with the same ecologically friendly principles as the Center

and is intended to expand the work conducted at the Forest by encouraging more scientific research to be conducted on site, an increased number of overnight visitations, and allow for more courses to be offered at the physical Forest.

Curriculum has been developed around the Center's green design and efficient energy consumption. The Center serves as a real life example and experiment in green design, an area that is seriously lacking meaningful curriculum and working models. Students may study the design and construction of the building through photo and video documentation, engage in visits where they examine the building's exposed green design elements, use technology to track and compare energy consumption, and acquire and analyze building sensor information. Lessons have been created where students study the self-composting toilets and their waste output calculating the water used and saved each day and the monetary savings involved. Students have examined the geothermal heating and cooling system first as a concept and then in practice at the Black Rock Forest graphing data and conducting cost analysis through the examination of comparable buildings using traditional methods for heating and cooling.

The Center is a real structure that encourages learners to immerse themselves in a working system and studying its efficient use of energy serves as a lesson is systems dynamics where learning is situated in real life. Access to the Center allows students to learn about, witness, and utilize the advanced technologies that are an integral part of the work of professional scientists. Additional positive pedagogical benefits of the Center include the ability for students to access real data; work in well equipped laboratories; utilize the same data collection, analysis, and modeling, tools that are used by real scientists; experience hands-on learning; and interact with professional scientists.

Since its opening the Center has garnished considerable positive attention; as a result, in 2003, the Center was nominated for a NorthEast Green Building Award under the Places of Learning Category.

> The energy efficient features of the Center, combined with the sensors that provide data on hourly energy use, also make it an important learning tool about the benefits of sustainable design for the students who use the facility.[131]

The conservation benefits of the Center have allowed the Consortium to receive a New York State Energy Research and Development Authority (NYSERDA) grant in the spring of 2003. The grant money is being used towards the funding the installation of solar panels that will harness the power of the sun and provide power to the Center and New Lodge. The panels will also be linked to the environmental monitoring network allowing for further scientific investigation.

As a result of the introduction of the New Center, the conversion of the old Forest headquarters into a 16 bed dormitory, and the new dormitory that can house 50 visitors; the Consortium hopes that new projects will continue to be introduced. Currently one of the largest projects at Black Rock and one that has grown as a result of the expansion of facilities is the Environmental Monitoring Project.

Environmental Monitoring Project

Technology has played a long and historical role in science, and most scholars agree that technological innovation and scientific discovery have a direct and symbiotic relationship. Science and technology advance to a large degree together, with scientists

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[131] North East Sustainable Energy Association: *NorthEast Green Building Awards 2003*. Retrieved August 2003. from http://www.nesea.org.

being dependent on technology and technologist relying on scientific developments to further their work. In fact, technology and science are so closely related that often technology is in and of itself considered to be a science. [132]

Scientists have been monitoring the ecology of Black Rock for some time. Currently, digital technologies assist the Consortium in its effort to study and make available scientific knowledge. Today, through a network of environmental sensors relevant ecological data is collected, transmitted through radio telemetry, and archived in a digital database. The information collected as part of this environmental monitoring effort produces data for such organizations as the National Acid Deposition Program (NADP), and the National Oceanic and Atmospheric Administration (NOAA).[133] Additionally, the Forest has partnered with the Organization of Biological Field stations (OBFS) to become a part of a national network of environmental monitoring sites that have joined together to share and disperse both current and historical primary ecological records.[134] Although some data is available online, the Forest staff responds to data requests making data available in any number of formats including email, disk, FTP, and hard copy. Historical data is obtained via request.

Beginning in 1995, an ecosystem wide network of environmental monitoring sensors was established representing the various terrestrial and aquatic areas of the Black Rock Forest. The monitoring network includes canopy access towers, a Geographic

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[132] Volti, R. (2001). *Society and technological change.* New York, NY: Worth Publishers. "Scientific knowledge can result in technological advances, while at the same time many technologies create both the opportunities and the motivations for new scientific discovery." (2001, p. 59)

[133] Shuster, W. (2002). *Modernization and expansion of the ecosystem monitoring network for scientists, students and educators at the Black Rock Forest field station.* Unpublished Proposal. Cornwall, NY: Black Rock Forest Consortium

[134] In addition to OBFS, NADP, and NOAA, other organizations which the Black Rock Forest Consortium is a member include the Northeastern Ecosystems Research Collaborative (NERC), the Global Terrestrial Observing System (GTOS), Association of Ecosystems Research Centers (AERC), and the Northeastern National Ecosystems Observatory (NEON).

Information System and a Geographic Positioning System base station. Currently, there are five monitoring stations; 1) open lowland terrestrial station, 2) ridge top terrestrial station, 3) stream sensor station located at Cascade Brook that monitors chemistry and water flow, 4) a series of sensors located in the Consortium's new green center, and 5) a station operated by the Consortium at West Point that collects wet and dry atmospheric conditions. These sensors measure such elements as precipitation, air temperature, barometric pressure, relative humidity, solar radiation, wind, temperature, oxygen, pH, stream discharge, and photosynthetically active radiation.

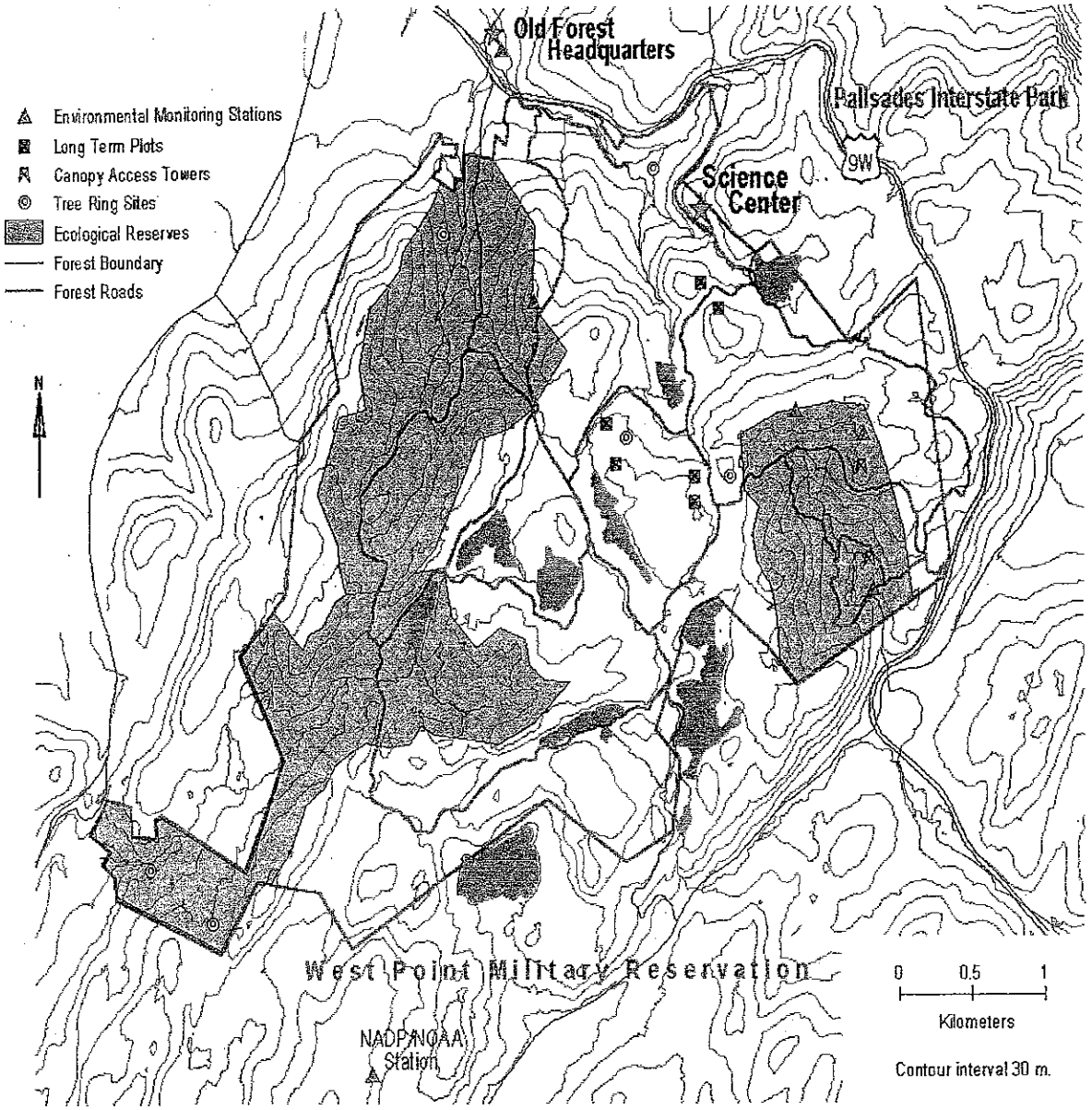

Figure 6: GIS Map of Black Rock Forest Field Station, courtesy of Black Rock Forest Consortium

Sensor information is transferred to Black Rock's headquarters via a radio telemetry system (except for the West Point station which is downloaded at frequent intervals) transmitted at a frequency of 151.835 Mhz making the data available in

virtually real-time.[135] The data is stored in the Forest's database. The management of the stations is the responsibility of four full time Forest staffers that include, the Forest Director, the Forest Manager, the Data/ Network Manager (who also manages the database), and an Administrative Assistant. To ensure the quality of the data collected through the environmental monitoring project a set of guidelines were adapted for data management. The data management policy that has been adopted by the Forest is in line with the guidelines set forth by the National Science Foundation and the Long-Term Ecological Research Network (LTER). As a result, the data collected is guaranteed to be of significant research quality. To expedite the access and transmission of data requests Forest's Data/Network Manager handles most of the data requests.

The information provided by the sensor stations allows individuals to track environmental changes on both a long term and short term basis. The data collected by the sensor stations is of particular significance because Black Rock is representative of the type of temperate deciduous forests that once blanketed the northeastern United States and that currently exist in increasingly smaller numbers.

> Such continuous environmental monitoring is critical in its own right to provide baseline data on ecosystem function. In a changing environment, only with accurate baseline records can one truly track environmental change and its consequences.[136]

This project was originally named the Virtual Forest Initiative. The mission of the project was first explained in 1998:

> To improve the quality of education and research at the Black Rock Forest and associated institutions, by constructing an ecosystem-wide network of

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[135] The Consortium has an FCC license to transmit via radio.

[136] Shuster, W. (1995, October). *Black Rock Forest Consortium Virtual Forest Initiative.* Unpublished Project Proposal.Cornwall, NY: Black Rock Forest Consortium.

> environmental sensors, together with the infrastructure required to collect, disseminate, analyze, place in context, and learn from, the resulting data. The Black Rock Forest project will serve as a national model for innovative use of real data, and real time data, for education.[137]

Currently, increased demand for sensor acquired information, an expanded desire to study more of the Forest, power problems during inclement weather, transmission difficulties with the existing frequency, has inspired a proposal for major improvement to the monitoring network. A grant proposal is in place that would expand the number of sensor stations by three.[138] The first added station is a meteorological station to be installed atop the Black Rock fire tower near the center of the Forest. This new sensor station will also act as a key repeater station in addition to its role as a monitoring sensor. The station will also have a web-enabled camera installed that will include panning and zooming capabilities with a goal of being able to transmit video over the network. A second sensor station will be located at the High Tower within the Cascade Brook watershed. The High Tower station has existed for four years independent of the monitoring network and includes soil monitoring probes and a Bowen radio tower. The new proposal seeks to connect this station to the radio telemetry network. The third new sensor station will be located at the Low Tower also a preexisting station independent of the network that is a canopy tower located at the bottom of the Cascade watershed. This tower includes soil, moisture, and temperature probes and will be enhanced by the addition of meteorological and carbon dioxide sensors. Additionally, the base station

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[137] Black Rock Forest Consortium. *Virtual Forest Initiative.* Retrieved 1998 from http://www.blackrockforest.org/vfi/overview.shtml

[138] Shuster, W. (2002). *Modernization and expansion of the ecosystem monitoring network for scientists, students and educators at the Black Rock Forest field station.* Unpublished report. Cornwall, NY: Black Rock Forest Consortium

located at the Forest's New Center will be expanded with the addition of a new radio antenna and an augmented sever/ data storage system.

> [T]he enhancements that we have designed will enable more productive interaction with the Forest for a wide range or scientific and educational purposes… The project will over time benefit thousands of individuals up and down the Hudson River Valley and beyond, and will enrich, simultaneously, the resources of more than a dozen academic institutions.[139]

[139] Shuster, W. (2002). Modernization and expansion of the ecosystem monitoring network for scientists, students and educators at the Black Rock Forest field station. Unpublished Proposal. Cornwall, NY: Black Rock Forest Consortium

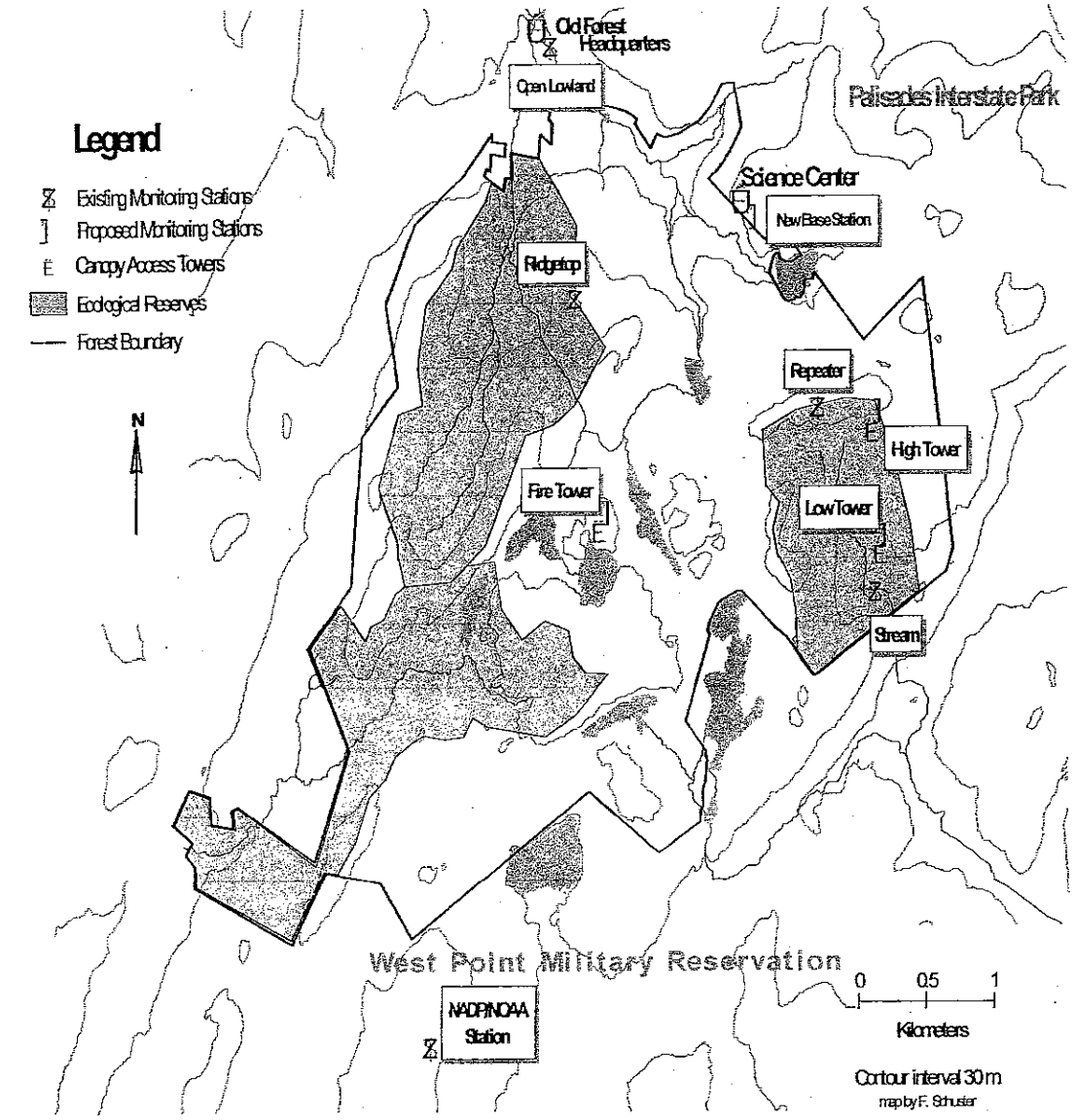

Figure 7: Locations of the existing and proposed stations in the ecosystem-monitoring network, courtesy of the Black Rock Forest Consortium.

The Consortium hopes to continue adding new sensor stations overtime. In the future the Forest will seek to add a lake station with sensors located at varying depths, a remote operated vehicle that will act as a pond rover, and a network of digital band dendrometers to track tree growth. Additionally, Lamont Doherty Earth Observatory plans to install a seismic station at Black Rock enabling further and deeper study of the region and its geology.[140]

The current proposal seeks to enhance the network, communications, and data management systems. These enhancements begin with increasing the rate of radio telemetry data transmissions from 151.835 Mhz to 900 Mhz with the addition of Novaroam mobile routers which will increase reliability, enhance bandwidth, and increase the rate of data transfer.[141] [142] A new base station at the Forest's New Center for Science and Education will be constructed. This network will also be accessible in the New Forest Lodge currently under construction. The scope of the network will be enhanced by the connecting of new sensor stations and the addition of a key repeater atop the fire tower. By improving the transmission of data to Black Rock's website, which is served at Columbia University, the Consortium intends to increase as well as expedite the accessibility of information.[143] The Columbia Center for New Media in Teaching and Learning (CCNMTL) will be developing the interface and software involved in accessing and viewing sensor data over the Internet. CCNMTL will also be responsible for

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[140] For more information on the future plans and proposals contact the Black Rock Forest headquarters at blackroc@ldeo.columbia.edu

[141] For more information on sensors, data loggers, and radio telemetry the NSF and LTER have conducted several key studies http://wireless.oldcolo.com/course.

[142] Novaroam radios and mobile routers are created for long range wireless networks. For more information on Novaroam technology visit http://www.novaroam.com/

[143] For more information on the pending improvements to the Black Rock Forest's environmental monitoring network read Shuster, W. (2002). *Modernization and expansion of the ecosystem monitoring network for scientists, students and educators at the Black Rock Forest field station.* Unpublished Proposal. Cornwall, NY: Black Rock Forest Consortium

examining and designing the methodology for serving video through the network from the fire tower station web camera. Additionally, CCNMTL will work on the development of learning exercises around the new data and interface. The Columbia Center for New Media in Teaching and Learning is a Columbia University organization involved with the research and development of educational technologies.

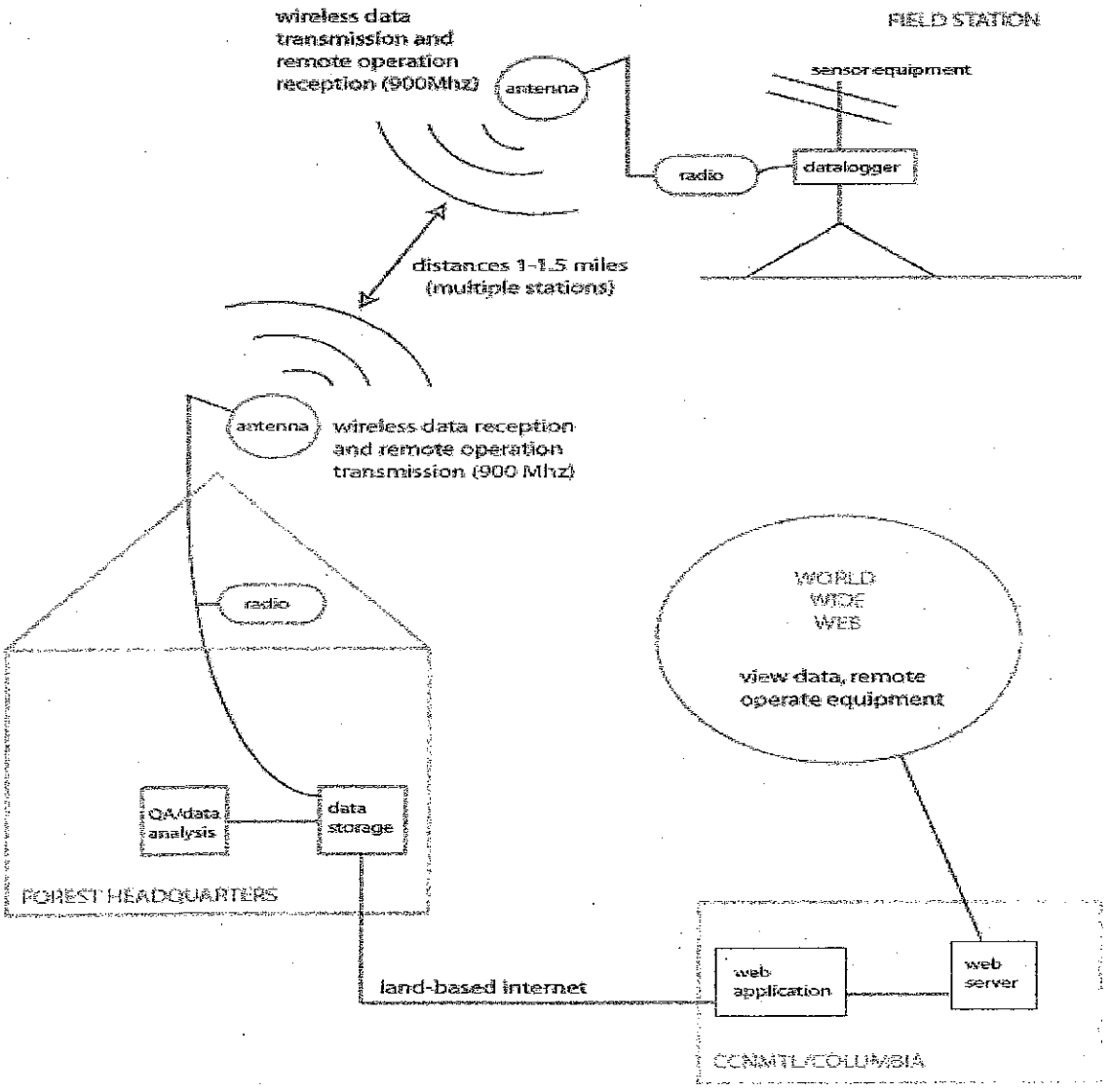

Figure 8: Schematic diagram of information flow over the expanded network. Courtesy of the Black Rock Forest Consortium.

The sensor-acquired information has become part of a data library made available to students and scientists through Columbia University's Lamont Doherty Earth Observatory (LDEO). It is accessible over the World Wide Web at http://www.ingrid.ldeo.columbia.edu. Information is accessed through the Data Viewer, a data retrieval and visualization program created by LDEO for use by scientists. The basic design of the data library is focused on assisting users in the location of suitable data through a variety of searches, providing a summary of the data, and allowing users to make use of the data through interactive visual display. The Data Viewer provides tables, data files, graphs, and a variety of other plotting methodologies. Controlling variables include the ability to zoom, select different data slices, choose temporal scales, overlay data over land maps, and control plot size and style. Additionally, the Data Library allows subsets of datasets to be delivered in a variety of data file formats, including netCDF files, HDF files, and ASCII tables.

For teachers and learners accessing the sensor data, an easier to use data visualization tool is available known as the Data Harvester, a spin off of the Data Viewer. The Data Harvester was developed by Benno Blumenthal of LDEO and is designed to be a user-friendly tool that allows students, teachers, and researchers to create data tables, time series graphs, and scatter plots of sensor data. A sample of the Data Harvester is made available (to a limited capacity) over the Internet through the Black Rock Forest Website and allows users to manipulate many of the parameters to be displayed such as dates, and axes. The current proposal in place will enhance that volume of information and the accessibility of that information made available through the Black Rock Forest website.

The Data Harvester was created to be simpler to use than the Data Viewer as it offers fewer selections and is designed to help guide users through the steps by limiting their selections to those that are relevant to the data type. Because it is considered more user friendly than the Data Viewer, several of the Data Harvester elements have since been incorporated into the Data Viewer.

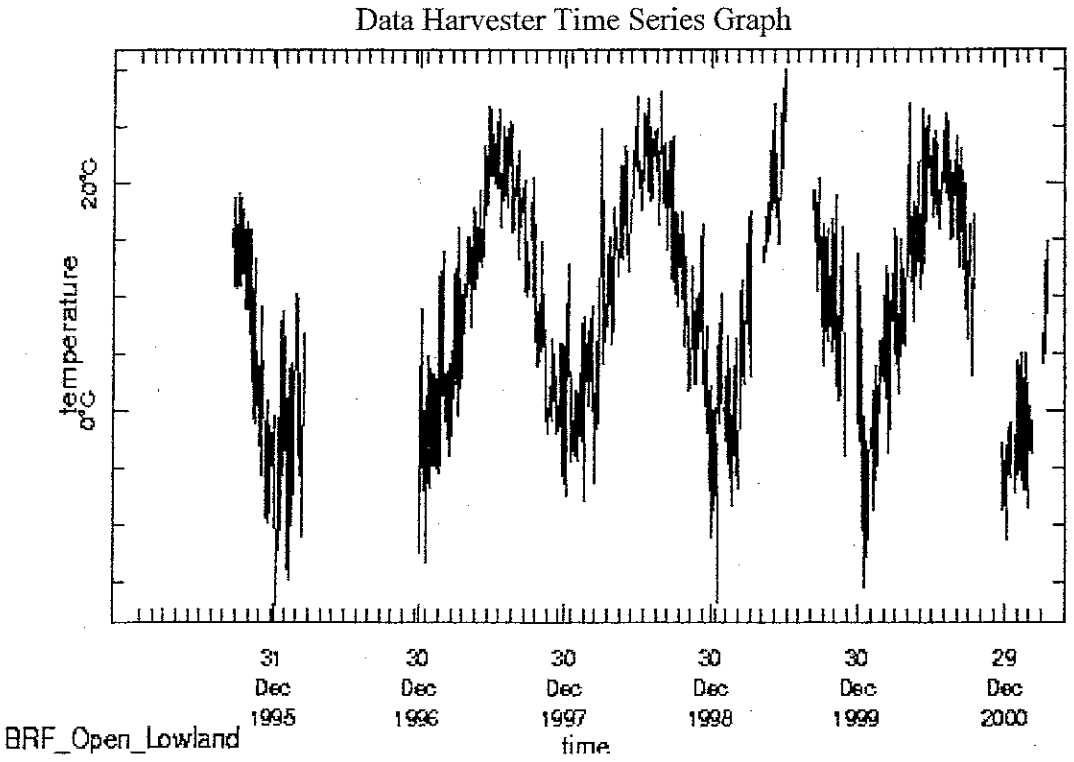

Figure 9 Data Harvester Graph, courtesy of the Black Rock Forest Consortium

Data Harvester Interface

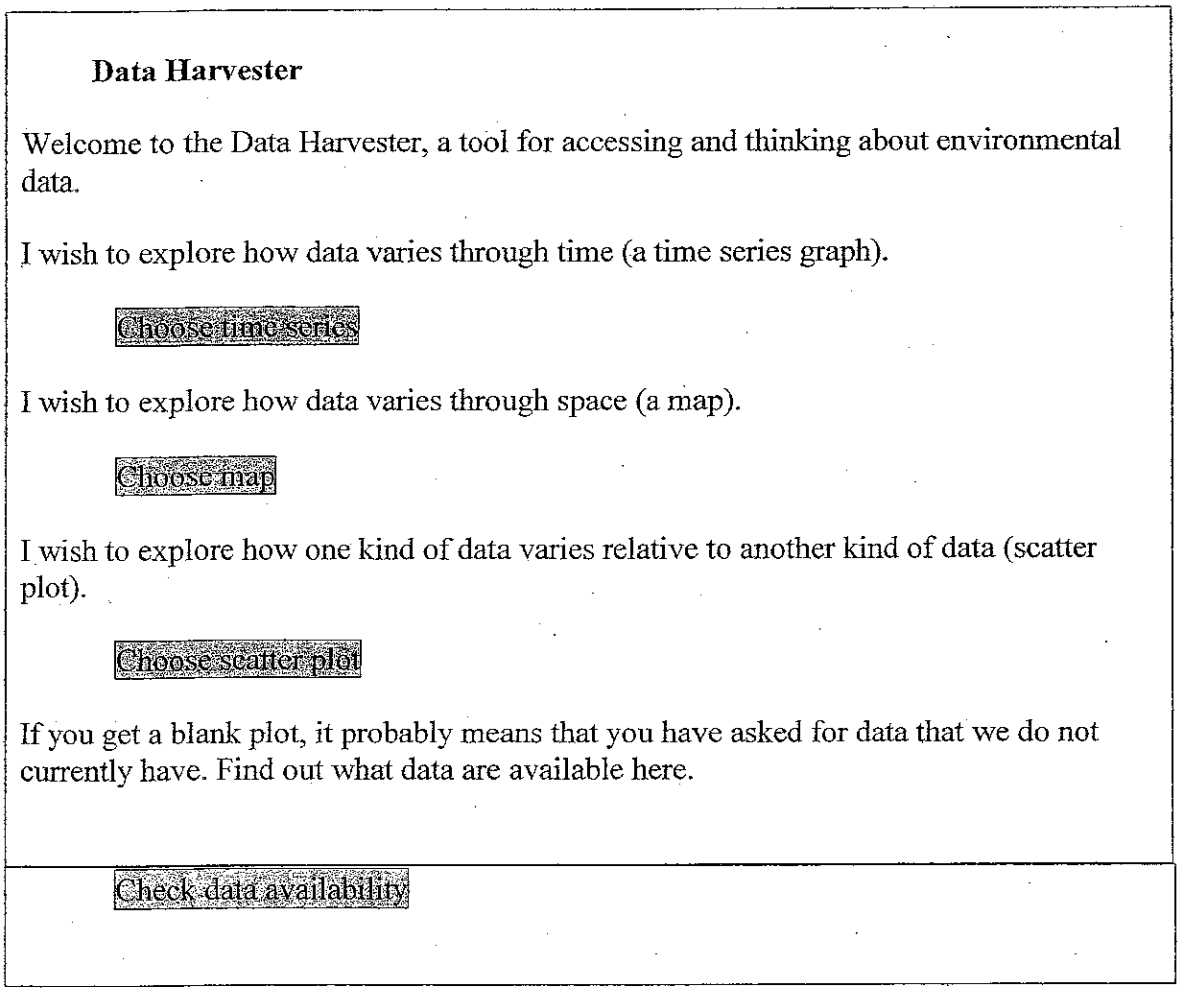

Figure 10: Data Harvester Interface courtesy of the Black Rock Forest Consortium,

This creation of this project has been a collaboratory process and funding has been received from several sources. Funding for the establishment of the sensors and telemetry infrastructure was assisted by grants from the National Science Foundation and the Hudson River Foundation. The Data Viewer was created by Lamont Doherty Earth Observatory of Columbia University. The Data Harvester was funded by the New Lab for Teaching and Learning at the Dalton School, a Consortium member institution.

Curriculum development has been created by funding and/ or assistance from the National Science Foundation, Americorps, the New Lab for Teaching and Learning, the New York State Department of Education North Hudson Electronic Education Empowerment Project, the Institute for Learning Technologies, Columbia Center for New Media in Teaching and Learning, and the Black Rock Forest Consortium.

Information gathered from the sensor stations has helped to inspire a series of curricula. According to Kim Kastens, a senior research scientist at Lamont Doherty Earth Observatory and part of the creative force that developed these investigations, "The common theme running through all of the existing investigations is that students should be able to 'discover' fundamental processes and phenomena about the Earth and environment by analyzing real data."[144]

Real data is information acquired as it is happening and under the actual conditions by which natural phenomena occur. When collecting real data investigators are not able to manipulate the conditions by which natural processes occur but rather act as scientists observing a natural occurrence. In the classroom students are most frequently exposed to historical data that resides in textbooks. When relegated to textbooks the data is abstracted and the students are disconnected from the data collection and the natural process itself. (Kastens, K. 1997) A goal of this project is to connect students to natural systems and the scientific process by having them work with the very

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[144] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictive investigations.* Unpublished Proposal to the National Science Foundation. New York, NY: Columbia University, Lamont Doherty Earth Observatory.

same data that is being studied by actual working scientists. According to Kim Kastens; "Learning direct from nature is exactly what scientists do."[145]

Kastens identifies several key attributes necessary to the use of the real data in teaching and learning: first, the data should be collected by the students so that students are more connected to both the data and the collection process; second, the data should cover elements that are understandable and can be sensed by the students own bodies such as temperature and wind speed; third, the data should help to illustrate trends and patterns as illustrated visually through charts or graphs, and the time being represented should be on a temporal scale that is meaningful to students such as days or weeks.[146]

The pedagogical methodology behind the sensor-developed curriculum is constructivist. It is built upon the idea that students all-too-often are exposed to science education that is de-contextualized. The desire is for students to be taught science using real data and exposure to actual scientific events. By being exposed to actual scientific processes students are able to make connections and understand the interrelatedness of natural systems.[147]

The study of science is an active process.[148] Scientific study requires individuals to hypothesize, explore, discover, evaluate, analyze, conclude, and collaborate. By learning through the understanding of real scientific data collected from nature representing actual earth processes, learners are able to build understanding as they

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[145] Kastens, K. (1997). *Earth Curriculum Workshop*. Unpublished Report. New York, NY: Columbia University.

[146] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictive investigations*. Unpublished Proposal to the National Science Foundation. New York, NY: Columbia University, Lamont Doherty Earth Observatory.

[147] Kastens, K. (1997). *Earth Curriculum Workshop*. Unpublished Report. New York, NY: Columbia University.

[148] Kim Kastens refers to science as a verb. Kastens, K. (1995). Earth Science as a vehicle for illuminating the boundary between the known and the unknown. *Journal of Geological Education*, v.43, p.138-140

experience anchored instruction where they take part in activities that occur within the context of their lives and the world around them.

The multiple representation of data helps to make learning more meaningful. The Data Harvester allows students to access a digital repository of data, and also provides students with the tools to represent the data in a variety of ways including spatially organized maps, graphs, scatter grams, models, and other images.

What is important in the successful design and integration of technology in scientific education is that the technology presents information that is more stimulating and intuitive than with traditional learning methods and that the learners are encouraged to discern, investigate, and make their own conclusions therefore authoring their own self directed learning experiences. Numerous studies have shown that well developed technologies enhance science education. Kaplan and Black noted that visual mapping technology can help students build effective mental models.[149] Black, Hachey, and Tseui found that computer-based learning tools enhance student development of scientific reasoning skills.[150] Sarapuu found that computerized learning in science education helps students with memory, comprehension, analysis, and the application of scientific knowledge.[151] Dede noted that the careful design of virtual learning environments that immerse students in the scientific process help build deep understandings of complex

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[149] Black, J. & Kaplan, K. (2001). Computer-based tools for the development and investigation of scientific reasoning skills. In Montgomerie, C. & Vitelli, J. (Eds.).*Proceedings of EdMedia world conference on educational multimedia, hypermedia & telecommunications*. Association for the Advancement of Computing in Education. 2001.

[150]Black, J., Hachey, A., & Tsuei, L. (2001). Fostering mental-model thinking during design. In Montgomerie, C. & Vitelli, J. (Eds.). *Proceedings of EdMedia world conference on educational multimedia, hypermedia & telecommunications*. Association for the Advancement of Computing in Education. 2001.

[151] Sarapuu, T., Adojaan, K., Hirmo, C., Laane, T., Mallo, L., Pata, K., Pedaste, M., & Puusepp, A.. *Designing visualized learning process through educational technology*. Retrieved August 2003, from http://www.ut.ee/biodida/e/teadust.htm

scientific knowledge.[152] Dede also found that multi-user virtual environments enhance student motivation in learning science.[153] White and Frederiksen cited studies that found that technology is an equalizer that helps to make scientific knowledge more accessible to all learners.[154]

Digital technologies are allowing for more creative and innovative science education that goes beyond the traditional drill and memorization of facts. The study of science deals with complex, multifaceted phenomena. In order to effectively understand science, students need to explore information, make their own decisions, and relate the information to real life. Technology facilitates the study of science by increasing the scope of available resources, allowing for expedient and reliable access to data and research material, enhancing collaboration, encouraging systems thinking, and by effectively delivering curriculum.[155] Real scientific inquiry involves hypothesis,

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[152] Ash, K., Dede, C., M. Loftin, B., & Salzman. (2000). In: Jackobson, M. & Kozma, R.*Innovations in science and mathematics education: Advanced designs for technologies of learning.* Mahwah, NJ: Lawrence Erlbaum Associates.

[153] Dede, C. *Museum related multimedia and virtual learning environments for teaching and learning science. NSF funded research on multi-user virtual learning environments.* Paper retrieved August 2003, from: http://www.virtual.gmu.edu/EDIT611/projdspt.pdf

[154] Frederiksen, J. & White, B. (2000). In: Jackobson, M. & Kozma, R.*Innovations in science and mathematics education: Advanced designs for technologies of learning.* Mahwah, NJ: Lawrence Erlbaum Associates.

[155] "Technology in schools can also be a wonderful link between academies and emerging practices in a host of professional fields. Science is conducted in very different ways today than it used to be.... Today practicing mathematicians and scientists in many cases not looking for a single answer but rather a host of answers through the design of models and simulations. Let's prepare our students for their futures by exposing them to the latest field practices."
Scalpeter, J. (1998). Interview with Cheryl Lemke. Ed Tech Research Forum. *Technology and Learning Magazine.*

exploration, discovery, and collaboration.[156] Technology helps students imitate the method of inquiry practiced by actual working scientists.[157]

Instructional technologists have recognized for some time that Technology infused learning can facilitate the multiple representation and revisiting of information in narrative forms that present various perspectives and that involve students in the solving of complex cross-curricular problems that are embedded in real-life, encouraging individuals to absorb, assimilate, and transfer knowledge, while building meaningful mental models. Studies by Kaplan, K. & Black; J.;. Black, J., Hachey, A., & Tsuei, L.; and McClintock, R.; Hill, C., & Black, J. have shown that well-developed student-centered computerized learning tools can support the creation of mental models and constructivist learning environments. [158] The sensor curriculum uses instructional technologies to create constructivist learning environments where students are both engrossed and immersed in interdisciplinary exploration. The curriculum developers acknowledged that intellectual technologies can allow students to role-play, collaborate, communicate, stimulate, research, discover, invent solutions, and reflect.

Simulation and modeling software supports cognitive variability as they help to bring ideas to life by enhancing illustration, control, experimentation, presentation, and

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[156] Edelson, D. *A national science education collaboratory learning through collaborative visualization: Overview of the Co Vis Project.* The Institute for Learning Sciences, Northwestern University. Retrieved July, 1999, http://www.covis.nwu.edu/info/projecy-overview.html,

[157] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictiveiInvestigations.* Unpublished Proposal to the National Science Foundation. New York, NY: Columbia University, Lamont Doherty Earth Observatory.

[158]Black, J. & Kaplan, K. (2001). Computer-based tools for the development and investigation of scientific reasoning skills. In Montgomerie, C. & Vitelli, J. (Eds.). *Proceedings of EdMedia world conference on educational multimedia, hypermedia & telecommunications.* Association for the Advancement of Computing in Education. 2001

Fostering mental-model thinking during design. In Montgomerie, C. & Vitelli, J. (Eds.). *Proceedings of EdMedia world conference on educational multimedia, hypermedia & telecommunications.* Association for the Advancement of Computing in Education. 2001.

Black, J., Hill, C., &. McClintock, R., (1994). *Assessing student understanding and learning in constructivist learning environments.* Paper. New York, NY: Teachers College, Columbia University.

by allowing for multiple representations. The importance of visual models is profound. When information is visually represented there is greater understanding and retention. Visual models that can be manipulated enhance the impact of data on students and allow learners to explore and view information in a way that is much more meaningful than through traditional de-contextualize text.[159] The modeling component of the curriculum allows students to represent scientific phenomenon in ways that provide realistic imagery and help them create mental models.

Real scientists examine systems. System dynamics is concerned with helping individuals achieve an understanding of the interaction of the parts of a system and of the system as a whole.[160] The systems dynamics approach to learning encourages students to understand the complexity of nature and of science. It is based on the concept of visual thinking, in which, images and diagrams are used to represent processes and the connections and differences between entities. According to the visual-thinking approach, when we acquire knowledge, we give it a shape or representation, and the best way to facilitate understanding and learning is by representing ideas in dynamic visual models.[161] The systems-dynamics approach encourages thinking in models, interrelated thinking, and dynamic thinking where students learn that the world is full of complex and evolving processes.[162] Systems dynamics has potential in all areas of study and is even

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[159] Black, J., Hachey, A., & Tsuei, L. (2001). *Fostering mental-model thinking during design.* In Montgomerie, C. & Vitelli, J. (Eds.). *Proceedings of EdMedia world conference on educational multimedia, hypermedia & telecommunications.* Association for the Advancement of Computing in Education. 2001.

[160] Bellinger, G. *Knowledge management emerging perspectives.* Retrieved August 29, 2003, from http://www.outsights.com/systems/kmgmt/kmgmt.htm

[161] McNamara, C. (1998). *Applied systems thinking.* Paper presented at the 1998 International Society for the Systems Sciences Conference. Retrieved January 2003, from http://www.tc.umn.edu/~ahler002/tft~1.htm

[162] Ossimitz, G. *Teaching systems dynamics and systems thinking.* Retrieved August 2003, from http://www.uni-klu.ac.at/users/gossimit/eng/sdyneng.htm

finding its way into the business world. Essentially, systems dynamics can be used to illustrate ideas that involve processes or cause-and-effect relationships.

The Black Rock Forest is a real working system and building the understanding of systems dynamics is a major goal of the Harvester curriculum. STELLA Modeling software is the tool used to promote a systems dynamics approach to learning in the Harvester curriculum by helping to illustrate the relationships of components in interrelated systems and allowing users to project future changes as well as to modify components and parameters. Information in STELLA is represented in dynamic graphs and models using what are known as a feedback control framework.[163] It allows users to create animated diagrams in the form of models and represent data in temporal graphs, tables of numeric values, and other numeric displays.

[163] Information on STELLA Modeling Software including a downloadable sample is available through the High Performance Systems Website: http://www.hps_inc.com

STELLA MODEL

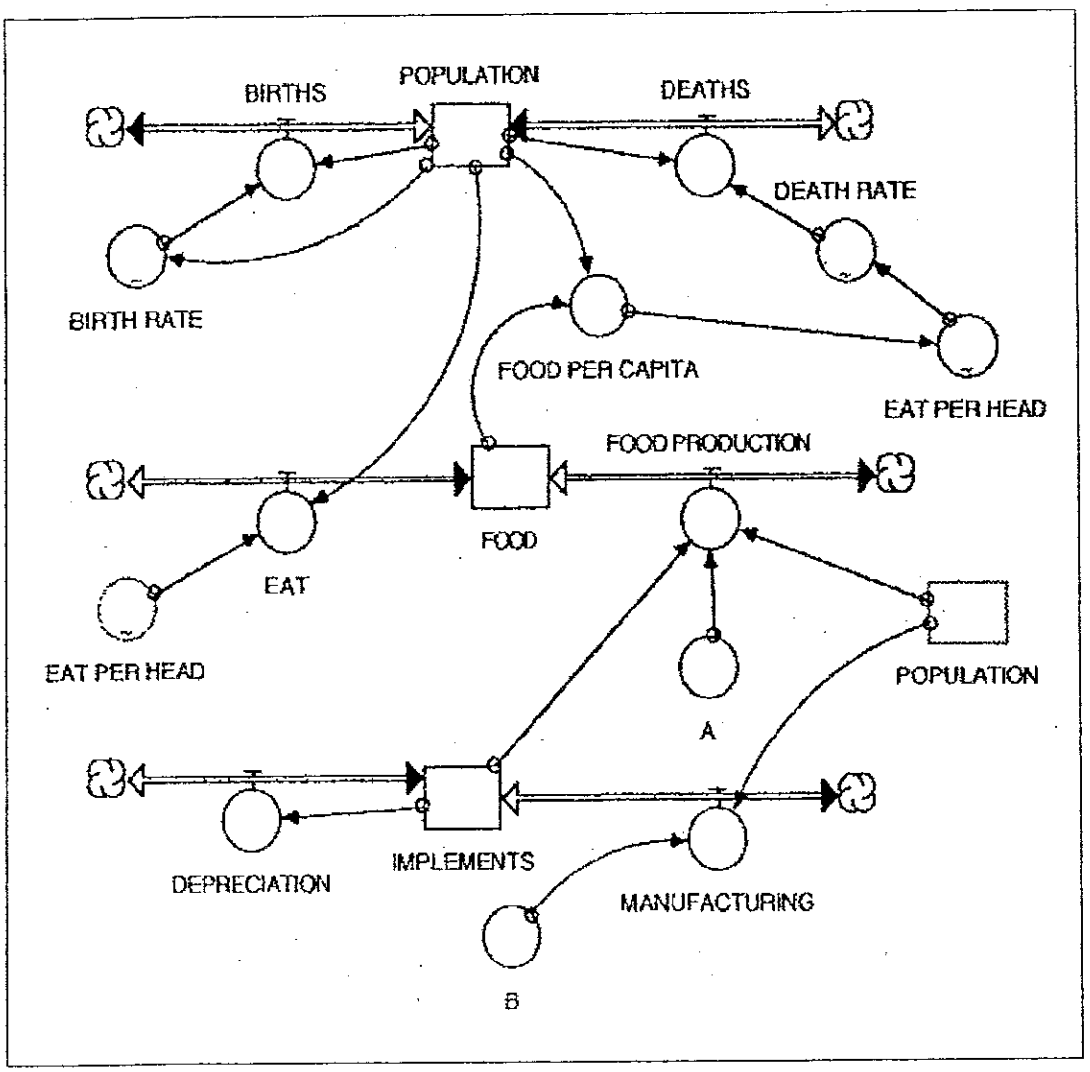

Figure 11: Sample still picture of an animated STELLA Model. Image courtesy of Graham, R.[164]

Real science involves the understanding of complex processes and natural systems. Natural systems are dynamic and involve numerous interrelated and dependent

[164] Graham, R. (1992, October-December). Retrieved January 2004, from http://access.ncsa.uiuc.edu/Archive/backissues/92.4/92.4Stella.html.

elements. These investigations are designed to help students learn and appreciate systems dynamics, and this aspect of the project is of tremendous pedagogical value.[165]

The Data Harvester curriculum puzzles were designed to help students learn to use the Harvester and modeling software and to utilize data collected from nature to develop conclusions, analyze systems, predict the future, and help solve real-world problems. The Harvester puzzles were created to be flexible and encourage students to think about and manipulate data and to become engaged in the scientific process. Investigations have been created for use in elementary through undergraduate levels and are currently being used in two colleges and five K-12 schools. The sensor data is available through the Black Rock Forest and the Data Harvester investigations are available through the Institute for Learning Technologies.

To further the use of the Data Harvester curriculum, funding from the New York State Department of Education North Hudson Electronic Education Empowerment Project has enabled the dissemination of the Forest's data based investigations to an additional 30 K-12 public school districts located in rural upstate New York. Recent assistance has come from the National Science Foundation and Columbia University's Center for New Media in Teaching and Learning.

The Harvester puzzles begin by asking students to solve real life questions such as: what type of clothing will be appropriate for a fall camping trip?, is a tent necessary for an upcoming wedding?, how deep should fence posts be place in the soil?, where is the least damp location for the storage of rare books at the Forest?, and/ or which side of the ridge top receives the least wind for the building of a patio?. In order to solve these

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[165] Kastens, K. (1997). *Earth Curriculum Workshop*. Unpublished Report. New York, NY: Columbia University.

questions students must implement the scientific method as they analyze real data and make reasonable predictions.

The *Fencepost Harvester Puzzle* poses the situation that the students will be installing a fence at the Forests open lowland site. The fence posts must be deep enough to go below the frost line. In order to solve the problem, the students use the Data Harvester to plot the soil temperature during the winter months. The students will learn that soil temperature varies slowly and that it is coldest during the months of January and February and that at 10 centimeters during the coldest months the soil temperature is at or below freezing but that at 100 centimeters the fence posts will be safe from freezing temperatures.

The *Wedding Tent Harvester Puzzle* involves a query into whether a couple should invest in a tent for June wedding or purchase better champagne. A tent is deemed necessary if the change of rain is greater than 25%. The decision has to be made two months in advance so televised weather predictions will not suffice, rather students take advantage of the time series capability of the Data Harvester to graph the hourly precipitation during the month of June for one year. Since afternoon rainfall is of the most concern the students can zoom in on particular rainy days to see if the rain fell in the afternoon. After the students add up the number of rainy afternoons they determine if there was more than 25% of afternoons with rainfall in the month of June, if there is, then the students decide that renting a tent is a sound investment.

The *Camping Trip Harvester Puzzle* has the students use air temperature and weather data to determine what type of clothing is appropriate for an October camping trip. Students also examine the difference between day verse night weather conditions.

Students plot time series graphs of precipitation and air temperature for the month in question learning that nights in October are significantly colder than during the day, which means that, while sweaters and pants are comfortable for the days all season sleeping bags will be necessary for the nights.

The *Dry Book Storage Harvester Puzzle* asks the students to determine the best place to store a collection of valuable books at the Forest, considering that the books need to be stored in an area of low humidity. The students compare data via scatter-grams that depict data that was collected from the ridge top and the open lowland to determine which area of the Forest has a lower relative humidity.

In the *Building A Patio Harvester Puzzle* students play the role of a builder who is designing a house to be built on the ridge top. A patio is to be built on the side of the house that receives the lease amount of wind and the students need to derive which side of the house is the least windy. The students examine wind direction and wind speed. They consider wind direction as an independent variable placing wind speed as a dependent variable. The students discover that the winds coming from the Northwest side of the house are the strongest while the winds coming along the eastern side of the house are the least strong.

In addition to the Harvester Puzzles, lessons have been created using sensor data covering such topics as stream flow, elements of water chemistry, conductivity of water, solar radiation, weather, wind speed and direction, precipitation, and air and soil temperature. For teachers interested in using sensor data in the classroom as well as gaining a host of ideas for teaching activities at or in conjunction with the Black Rock

Forest, the Consortium has published *A Teachers Guide to the Black Rock Forest: A Manual for Use in the Classroom* (2003).[166]

Real Time Data

Currently, increasing technological capability made available at the Forest is enabling accessibility to real time data or the observation of phenomenon that is occurring and collected as individuals are exploring the information. Making real time information available involves data flowing from the sensors via radio telemetry to the Forest's Campbell (NT) Data Collection Computer to the Black Rock Forest's Network then the information is transferred to a server where it travels is placed on the World Wide Web and made available to teachers and students in the classroom via the Forest's website.[167] A current proposal seeks to expedite this process by augmenting data transmission, access, and storage.[168]

The modified curriculum developed around the use of real time data involves students examining archival data so as to gather a historical analysis of the different elements of a natural process through modeling and comparing the data. The students then make predictions for a few days into the future and are later able to gather current real time data comparing their predictions with actuality.

The first curricular exercise developed as a investigation using real time data has the students examining stream discharge collected by the Cascade Brook sensor station as

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[166] Daly, A. (2003). *A teacher's guide to Black Rock Forest: A manual for use in the classroom and in the field.* Cornwall, NY: Black Rock Forest Consortium.

[167] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictive investigations*. Unpublished Proposal to the National Science Foundation. New York, NY: Columbia University, Lamont Doherty Earth Observatory

[168] Shuster, W. (2002). *Modernization and expansion of the Ecosystem Monitoring Network for scientists, students and educators at the Black Rock Forest field station.* Unpublished Proposal. Cornwall, NY: Black Rock Forest Consortium

well as precipitation data collected by one of the Forest's terrestrial stations. Students are asked to examine historical data on rainfall and stream discharge making comparisons and using information on hydrology to make a prediction depicted in a model to predict expected stream discharge in a few days into the future. As the data draws closer students may modify their predictions based on current rainfall data (but are not to examine more current stream flow data). More advanced students may also choose to manipulate data after downloading a Data Harvester data table into an Excel spreadsheet. Others may choose to compare additional elements for further inquiry to see for example how something like soil temperature effect run off which they can determine may or may not have an impact on the rate of stream discharge. High school students should be able to create an empirical model as they go through the archival data in the data library to find weather conditions that are similar to those at present making minor changes in the data to reflect more current conditions. College students develop complex and dynamic models using the STELLA modeling software where they build models of fluxes, sources, sinks, and reservoirs.

In order to be more effective in the delivery of real time data modifications and improvements have and are being made to the Data Harvester user interface. These changes include: pull down menus for adding start and end dates, choice of line or dots for the representation of time series graphs, more choices in the representation of data (e.g. Celsius verse Fahrenheit), and more documentation of meta-data elements. According to Kim Kastens, "Our goal is to have as seamless as possible a pathway from

nature through various computers and networks, into the brains and imaginations of student users."[169]

The benefits of real time data includes data integrity by allowing students to better recognize and deal with data irregularities and imperfections, encouraging individuals to consider meta data and respond to occurring environmental phenomena, helping to better connect students to scientific processes and data collection, and by allowing educators to design inquiries that involve students predicting events that have yet to occur. Students can discuss with each other the probable causes of data irregularities and when appropriate individuals can respond or modify their actions to an event as or immediately following its occurrence.

Using real time data also makes experiences with curriculum more unique in that time, data, and conditions alter data elements ensuring that each group of students has a unique self-authored experience. The ability for learners to make their own predictions is valuable. With traditional textbook derived laboratory exercises the outcome and the elements involved are usually fixed. Students recognize that their goal is not to author, interact, and discover based on scientific processes but rather to simply replicate a phenomenon in a de-contextualized, artificial, and fixed setting. With the use of real data students participate in the scientific process in much the same way as actual working scientists using the very same data that is being used by and is benefiting working scientists. Teachers and students are able to make predictions that are testable and

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[169] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictive investigations*. Unpublished Proposal to the National Science Foundation. New York, NY: Columbia University, Lamont Doherty Earth Observatory.

capable of being witnessed helping to further engage and involve students in the scientific process.[170]

> Most adult geoscientists have spent most of their education and their careers thinking about the past. But today, most of the questions that society is posing to the geoscience community have to do with the future. We need to find ways to train our students to think rigorously but boldly about the future. Predictive investigations are one way to do this.[171]

The environmental monitoring network component of the Black Rock Forest greatly helps to expand the mission statement of the Consortium. The sensors help to provide key aquatic and terrestrial historical, archival, and current data to scientists within the Consortium as well as researchers working at a distance. Through participation in the Organization of Biological Field Stations and in cooperation with Lamont Doherty Earth Observatory the Consortium is able to contribute to a national infrastructure of scientific data that provides information and helps create linkages across scientific institutions.[172]

Curriculum that has and is being developed around the sensor data follows constructivist pedagogy where students are actively involved in the scientific process through meaningful interactions that place them in real life scenarios. The curriculum project allows students to interact with real data and encourages the students to take on the role of actual working scientists. The curriculum teaches the understanding of systems thinking and the appreciation of the cause and effect relationships involved in systems dynamics. The use of technology allows students to learn through models and

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[170] Kastens, K. (personal interview, 2000).
[171] Kastens, K. (1999, March 3). *Adding real-time data to the Black Rock Forest digital library to enable students to engage in predictive investigations*. Unpublished Proposal to the National Science Foundation. New York, NY: Columbia University, Lamont Doherty Earth Observatory.
[172] The sensors are also providing data to the NOAA and the NADP.

graphs and interact with superior database technology helping the learners create meaningful mental models. This project serves as an exemplar for the development of relevant environmental science curriculum using innovative approaches that take advantage of new technologies. This project seeks to assist the application of the National Science Foundation's Digital Technologies to Undergraduate Education goal by making available to learners digital access to validated research quality data and tools for the analysis and visualization of the data, and the use of the World Wide Web to make available a compilation of curriculum materials.[173]

Although the Environmental Monitoring Project is certainly the largest project that currently occurs at the Forest, Black Rock has helped to give birth to other large-scale projects. The Summer Ecosystems Experience for Undergraduates no longer takes place at the Forest but was created by Consortium members, assisted by Forest staffers, and was held for its first few years at Black Rock. Although it no longer occurs at the Forest, it is still worthy of examination because it provides an example of how this preservation property with its convenient proximity to New York City's major educational institutions, highly skilled staff, and encouraging Consortium membership, can help to create innovative learning experiences that help to link scientific practice and science education by having students take part in the collection of real data; use advanced professional scientific gathering, analysis, and modeling technologies; collaborate and

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[173] The National Science Foundation has created two programs called Awards to Facilitate Geoscience Education and Application of Digital Libraries to Undergraduate Earth Systems Education. The first program seeks to increase the involvement of researchers in science education and the second seeks to encourage the use of technology to increase learning, the development of key skills, and scientific analysis. For more information visit http://apps.rgp.ufl.edu/research/fyi/back_issues/v27n14/fyi077.cfm.

communicate with professional scientists as well as fellow students; and build key skills that are at the cornerstone of real scientific work.

The Summer Ecosystems Experience for Undergraduates

The Summer Ecosystems Experience for Undergraduates, otherwise known as SEE-U, is one of the most technologically dependent programs to develop with the assistance the Consortium. It is offered through the Center for Environmental Research and Conservation (CERC), headquartered at Columbia University (a Consortium member institution). The website for the program was created by the Columbia Center for New Media in Teaching and Learning (CCNMTL) and can be explored through http://www.columbia.edu/itc/cerc/seeu. CCNMTL is an instructional technology development center also housed at Columbia University and that is involved with several technology related projects at Black Rock including the environmental monitoring network, and the Black Rock Forest website.

The five-week SEE-U course is offered to students at colleges and universities throughout the world. It is a total immersion course promoting anchored instruction held initially at Black Rock Forest and now at more distant field sites in Brazil and the Dominican Republic.[174] Students enrolled and participating in the SEE-U program concentrate on the examination of one biome but make comparisons with and learn about others. The learners explore biomes globally and locally, developing an understanding of the population ecology, biotic and abiotic processes, community ecology, conservation, and pollution and habitat fragmentation.

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[174] For information on the SEE-U program including course curriculum visit the program website at http://www.columbia.edu/itc/cerc/seeu.

Scientists rarely work independently and in isolation from other scientists. As a result, participants in the course conduct scientific research and make discoveries in cooperative learning groups. Because success for the students is largely dependent on collaboration, learners develop an understanding that science is in and of itself a collaborative practice.

SEE-U involves a technology-facilitated curriculum, which requires the students take part and implement the scientific method. According to SEE-U, the novel technology enhanced aspects of the SEE-U program include global networking, GPS/GIS training, electronic discussions, data collection, data manipulation, online lectures, bulletin board discussions, online office hours, links provided to relevant resources, online demonstration videos, networked simulations, and the completion of collaborative as well as an independent research project. (SEE-U, 2001)

The students begin with background information and an initial question for investigation. Throughout the course they investigate the question by gathering data and testing out different hypotheses, in the same manner that actual working scientists conduct their own professional endeavors. The hands-on experimental aspect of the SEE-U course helps the students to develop and build scientific research skills. According to Consortium board member Sybil Golden, "It differs from other field courses by emphasizing experimental methods."[175]

The SEE-U curriculum comprises 4 major sections, biomes, biotic processes, abiotic processes, and contemporary issues. Biomes covers the understanding of the world's major biomes as well as provides an in-depth focus on the local biome where the students are immersed for study. The section on biotic processes includes natural

[175] Golden, S. (2000, Fall). *Black Rock Forest Newsletter*.

selection and evolution; growth and competition, otherwise known as population dynamics; community ecology; the basis of ecosystems, or the producers, herbivores, predators, and parasites or consumers; and, finally, the end of the biotic process – the decomposers. Abiotic processes covers the role of light and temperature, geology and soils, chemical and hydrological cycles, and geological disturbances. Contemporary issues studies the social, political, and ethical issues that are of concern to the biome. These contemporary issues include such elements as habitat fragmentation and deforestation; the introduction of foreign species and their impact on an ecosystem; the effect of pollution and global warming; and conservation solutions through mediation, restoration, and preservation. Within each section, topics are broken down into modules. In total there are 16 modules with each taking one or two days to cover. The learning modules include experiments. Throughout the five-week course the learners participate in roughly 20 experiments. Most of the experiments involve group work, culminating with the students designing and implementing their own independent research projects. During the experiments, learners enter the field and collect data, later conducting simulations and modeling to analyze their findings. Students work with both archived and new data – seeking, analyzing, and learning from networked information – presenting the total of their work.

Most educational theorists agree that intellectual discussion facilitates learning.[176] The learners in the SEE-U program enter into relevant discourse as they participate in online discussions, take part in collaborative research, share and compare findings,

[176] Vygotsky. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

conduct networked simulations, and hear and participate in lectures and discussions given by scientists across the globe.[177]

Since it began in the summer of 2000, the SEE-U program has attracted students from all over the world. It involves both an in-depth field and technology-based introduction to ecology and environmental studies. Digital technologies are used throughout the course to help students explore, gather, analyze, visualize, and compare data. At the core of the Summer Ecosystems Experience is the use of EBiome, which is a geo-spatially referenced database. During the program, participants embark to the field and collect data using GIS instrumentation, bringing it back to headquarters where the data is entered into the EBiome database. Datasets in EBiome can be reference and compared spatially, topically, or by biome. Students participating in the SEE-U program are encouraged to compare their data to archival and to data collected by their counterparts at the other participating sites. The students discuss information across locations as they enter into relevant discourse through interactions with learners at other biological field sites via the network.

SEE-U is dependent on and uses technology in interesting and innovative ways serving as an example for other courses. The program uses technology in the acquisition, analysis, modeling, and comparison of data but also to foster communications, collaborations, the sharing of data, comparisons, discussions, debate, the deliver of curriculum, and further research. Students participating in the SEE-U program take advantage of Geographic Position System (GPS) technology to spatially reference data; Geographic Information System (GIS) technology to allow detailed mapping and

[177] For more information on the curriculum of the. Summer Ecosystems Experience for Undergraduates Program Visit the CERC website: http://www.columbia.edu/itc/cerc/seeu/index.html

topographical representation of data; modeling software for the visualization of and experimentation with data; detailed computer networking; online research; digital lectures and demonstration videos; live discussions; and advanced database technology that is multi-queriable, including meta-data information. "Field and laboratory exercises and hand-on experiences are enhanced with digital exercises, including the use of computer models to experiment with ecosystems by changing system variables."[178]

Although the SEE-U program is a total immersion course, it is designed and delivered in many ways as a distance-learning course. Course information is completely delivered online, including lecture notes, slides, text, video, web links, online subscriptions to relevant scientific publications, etc. One of the benefits of the online delivery of information is accuracy in delivery and the ability for students to visit and revisit course information according to need and interest.

Global networking allows the learners to communicate and collaborate across all of the program's biological field sites as students to share data and work on research projects together. As a result, this course helps illustrate the global nature of the scientific community and the importance of sharing and comparing discoveries with other scientists.[179]

Perhaps the most unique part of the SEE-U experience is EBiome. EBiome is the digital database that is designed to serve as a central repository to what is increasingly becoming significant and copious amounts of longitudinal data. According to CERC, "eBiome is an innovative, integrated tool for storing and retrieving all types of field-ecology data, ranging from climatic and abiotic information to ethological and behavioral

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[178] Center for Environmental Research and Conservation. (2000). *Five biomes project.* Unpublished Handout.
[179] Dandoff-Burg. (personal interview, 2000).

data."[180] EBiome was created specifically for the SEE-U program and is one of the most unique and integral parts of the course. EBiome was created by the Center For Environmental Research and Conservation (CERC), the Columbia Center for New Media in Teaching and Learning (CCNMTL), and the Center for International Earth Sciences Information Network (CIESEN). All of the data that is collected as part of the student investigations is entered into EBiome and can be accessed by all who are participating in the program onsite or remotely, as well as by instructors and research scientists the world over. The database is designed to encourage data comparison so that learners can examine the differences of processes across biomes. The SEE-U program website notes,

> Data collected during the SEE-U program will be used by some of the world's most prestigious researchers. Students participating in the program will not only learn the most important techniques in field ecology, but they will also have the unique opportunity to assist leading scientists in answering overwhelmingly important questions in conservation biology.[181]

When field data is collected by students, Global Positioning technology is used. GPS technology involves the use of radio signals received from at least four satellites that exist in geo-synchronous orbits circling the Earth. GPS makes it possible to pinpoint exact locations where data is collected. Student use the GPS system to determine the precise latitude and longitude where data is collected. Upon returning to base station the students input their data into the specially designed EBiome database. Students enrolled in the SEE-U course are well versed in the use of Ebiome. Prior to working with the

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[180] Center for Environmental Research and Conservation. Summer Ecosystems Experience for Undergraduates Program at Columbia University. Retrieved August 2002, from http://www.columbia.edu/itc/cerc/seeu

[181] Center for Environmental Research and Conservation. Summer Ecosystems Experience for Undergraduates Program at Columbia University. Retrieved August 2002, from http://www.columbia.edu/itc/cerc/seeu

technology, students are trained in its proper use and many features. This training is built directly into the course curriculum.

E-Biome Data Logger

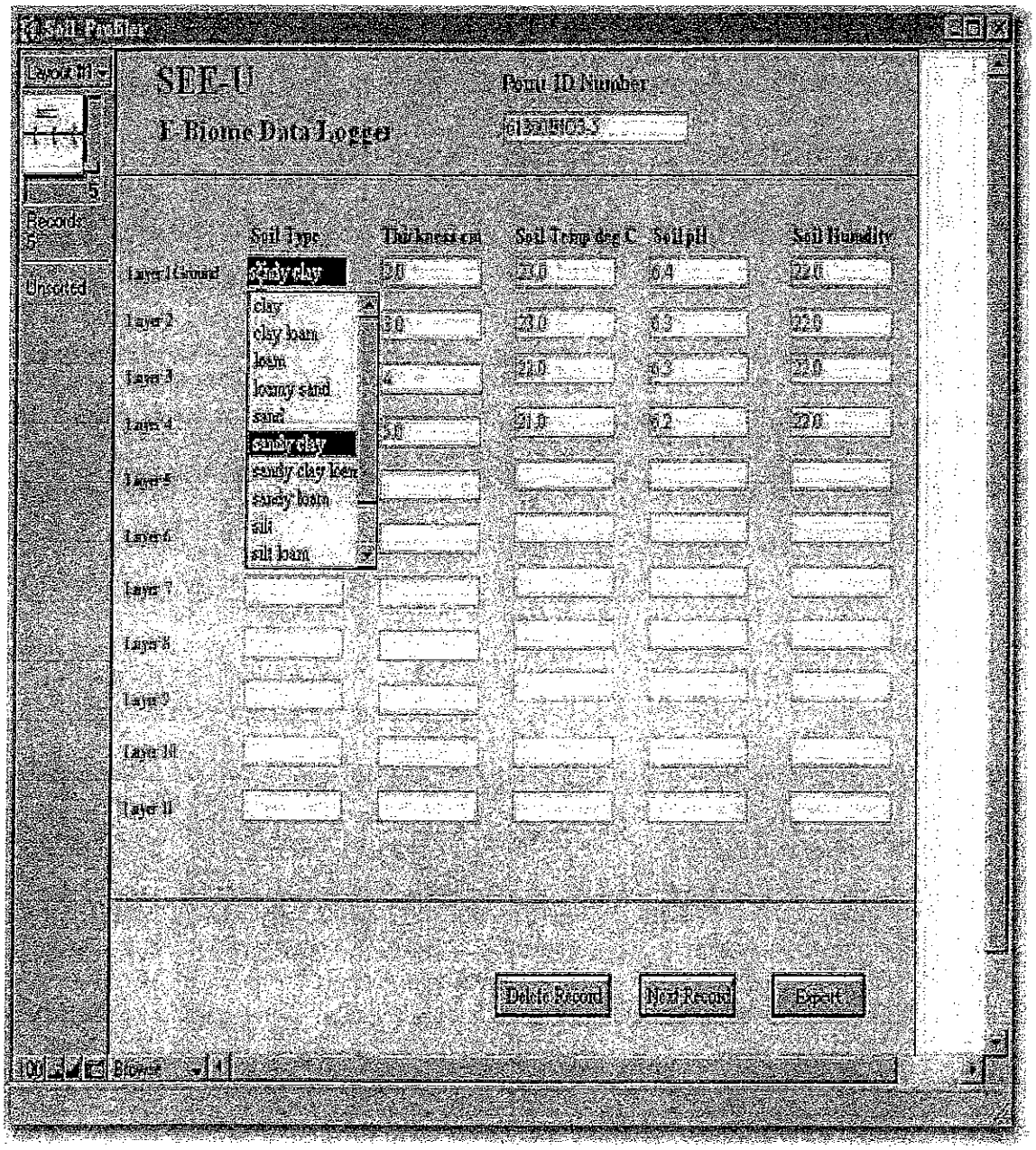

Figure 12: E-Biome Data Logger, courtesy of SEE-U/ CERC

Ebiome is a versatile and multidimensional database that allows users to query information in numerous ways and across sites. For example, users may search data sets by any number of characteristics such as data type, by spatial reference, and or by the date or time of the data collection. Users can set parameters for querying data such as soil ph>6.4<3.2. Additionally, Ebiome includes copious amounts of metadata elements, which help to insure data accuracy and integrity and allow for additional forms of inquiry. According to CERC the benefits of Ebiome are the storage of data for longitudinal study and comparison, the referencing of data and compilation in a digital repository, the geo-referencing of data, the amount of metadata included, and that students take part in the data-collection process. According to individuals involved with the SEE-U program, "Field and laboratory exercises and hands-on experiences are enhanced with digital exercises, including the use of computer models to experiment with ecosystems by changing variables."[182]

Ebiome allows data to be represented spatially using Geographic Information System (GIS) technology. Visual mapping programs such as GIS have been shown to help learners build effective mental models.[183] The GIS program used by SEE-U was specifically designed and formatted for use by SEE-U. GIS is a dynamic mapping system that allows individuals to collect, manage, and spatially reference volumes of data. GIS involves a series of aerial photos that have been digitized allowing for the construction of elevation models. Additional information is later entered on roads, trails, streams,

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[182] Center for Environmental Research and Conservation. (2000). *Five biomes project.* Unpublished Handout.

[183] Black, J. & Kaplan, K. (2001). Computer-based tools for the development and investigation of scientific reasoning skills. In Montgomerie, C. & Vitelli, J. (Eds.). *Proceedings of EdMedia world conference on educational multimedia, hypermedia & telecommunications.* Association for the Advancement of Computing in Education. 2001

landmarks, and other features that may not be included in aerial photos. Information displayed in GIS involves the overlaying of maps where map layers represent different geological characteristics. For this project, the information is accessible using the ESRI Arc View Software. The Trimble GeoExplorer mapping system is the field receiver that accepts the GPS information. The Trimble GeoExplorer and the ESRI Arc View software allow individuals to quickly learn how to collect, enter, and correct, and map data.

Arc View Image

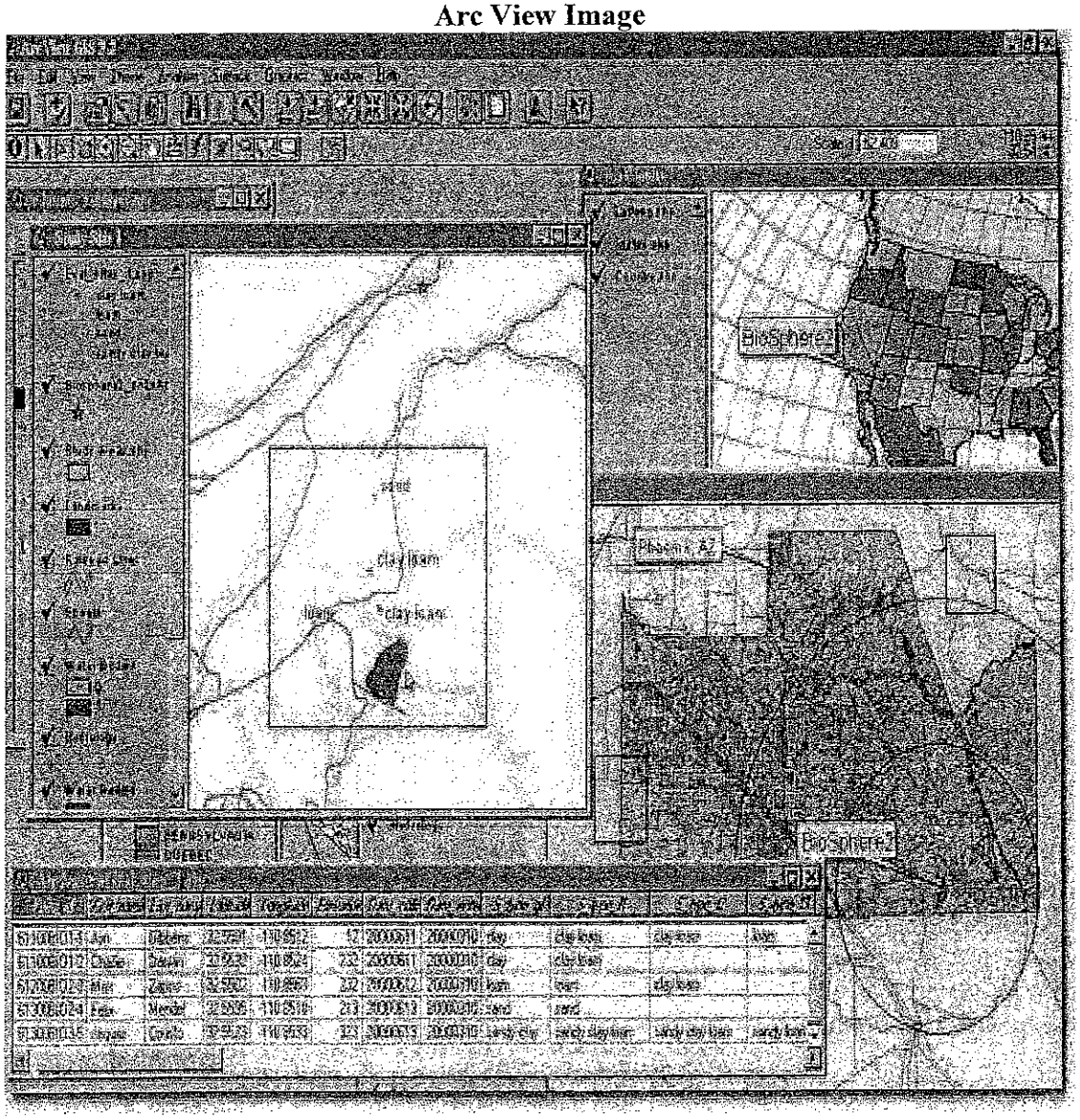

Figure 13: Arc View, courtesy of SEE-U

One of the goals of SEE-U is to help introduce science students to scientific practice. According to CERC, when students complete the SEE-U curriculum, they have developed a mastery of several key concepts, including, an understanding of the scientific method and its underlying theory; knowledge of the multilevel interaction of ecological elements and an appreciation of the importance of not disturbing these relationships; an understanding of the human impact on the environment; insight on the interaction of the world's biomes; illustration of ecological and biological diversity; understanding of the Darwinian concepts of natural selection and evolution; comprehension of population dynamics and the natural constraints that usual limit population size; knowledge of the chemical cycle within an ecosystem; the ability to work with cutting edge scientific research technology; and an appreciation for human conservation, mediation, and preservation efforts. The five-week structure of this total immersion course allows students to learn these numerous and multifaceted concepts in a rather expedient time frame.

Not only is the SEE-U program concerned with building knowledge, it is also designed to help students learn several key skills. According to CERC, these skills are a cornerstone of being a successful science student and later in a career as a professional working scientists and include; the ability to implement the scientific method and incorporate it into meaningful experiments, understanding primary statistical methodologies and the ability to conduct and select appropriate simple statistical analyses, knowledge of different field and laboratory techniques, the ability to gather data from a wide variety of sources and determine the relevance of that data, aptitude in preparing and presenting logical oral and written scientific research reports, and the

understanding of the importance of and the use of technological instrumentation to enhance scientific research.[184]

The ability to work with and use technology is becoming a paramount skill to the scientific community. The technological skills involved in the course include the ability to use GPS units and methods to post, process and geo-reference data; an understanding of GIS and the ability to input, retrieve, format, and visually display data in GIS format; the ability to search the Web for academic-quality information; and the ability to use computer models to interpret information. The use of Ebiome is at the forefront of the development of technological skills during the SEE-U program. The SEE-U Website outline the technological goals of Ebiome,

> Ebiome will enable students to gain three important technological skills; using GPS, familiarity with databases housing ecological data, and use of the most commonly used GIS package. These skills will be some of the most important skills required of conservation biologists in the new millennium![185]

Students analyze data, forming hypotheses and exploring different methodologies for answering various open-ended questions. Students participating in the course are able to merge collaborative scientific practice, fieldwork, lab examination, technologically enhanced data analysis and representation, and web based exercises. As a result of the activities included, the SEE-U program has been designed to bridge the gaps between scientific practice and learning.

This unusual educational program may not have been developed without the Black Rock Forest Consortium. The Forest and the Consortium have played major roles

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[184] For information on the goals of SEE-U visit http://www.columbia.edu/itc/cerc/seeu.
[185] Center for Environmental Research and Conservation. Summer Ecosystems Experience for Undergraduates Program at Columbia University. Retrieved August 2002, from http://www.columbia.edu/itc/cerc/seeu

in the development of the SEE-U program. Forest staff members assisted in the development of the course outline and activities, work that has been used when modeling the SEE-U program at the other sites. The Black Rock Forest Director, Dr. William Shuster, was instrumental in the design of SEE-U, which included his creating the course curriculum. The SEE-U program was designed with the Forest in mind and the Forest served as the inaugural field site. According to the SEE-U Program Director, Dr. James Dandoff-Burg, "Black Rock Forest has been the laboratory within which we largely created the SEE-U program."[186] Dr. Dandoff-Burg also believes that SEE-U and Ebiome exposure provide a unique experience that is unparalleled in field-science education through the use of experimental learning methods, and the implementation of cutting edge environmental monitoring technology.[187]

The Consortium should be pleased that they helped create and give birth to this unusual educational experience. The SEE-U program typifies how this valuable landscape conveniently located to New York City's major educational institutions, the highly skilled Forest staff, and encouraging Consortium membership, can help to inspire, develop, and launch innovative learning experiences that help to link scientific practice and science education.

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[186] Dandoff-Burg, J. (2000, Fall). *Black Rock Forest Newsletter*. p. 6.

[187] Center for Environmental Research and Conservation. Summer Ecosystems Experience for Undergraduates Program at Columbia University. Retrieved August 2002, from http://www.columbia.edu/itc/cerc/seeu

Issues the Black Rock Forest Consortium Faces

Although we have examined some of the positive attributes and edifying projects that have emerged out of the Black Rock Forest Consortium, it is important to note, the Consortium is certainly not without its flaws. When Forest staffers and Consortium members were asked to cite the weaknesses of the Consortium the overwhelming response was a lack of financial resources. Another common response included a lack of staffing to meet demands. This latter short-coming may be considered a byproduct of a lack of financial resources.

The Consortium is primarily funded through the approximately $10,000 annual membership dues required of all Consortium members. This money is not sufficient to cover the entire operating budget of the Forest, which in recent years has continued to grow with the building of the Science and Education Center and the New Lodge. Although, the membership fee would be considered low to many it can be cost prohibitive to under-funded institutions such as inner-city public schools.

The Forest currently maintains a staff of five; the Forest Director, the Forest Manager, the Forest Data/ Network Manager, an administrative assistant employed three quarter time, and a half time education coordinator. The Forest also frequently seeks the assistance of temporary or part time staffing. Additionally, with the opening of the new lodge eminent the Forest plans on hiring a new full time facilities manager. The Forest's small staff which is paid largely out of the Consortium's operating budget is responsible for Forest maintenance including all roadways, buildings, plant, and biological life; the preservation of Forest archives and publications; the management of long term research plots; the organization of Forest visitations; continuous community relations; cataloging

data and handling data requests; assisting Consortium members in project development and implementation; making educational resources available to teachers and learners; running workshops; the management of technological resources; participation in relevant scientific organizations such as the OBFS, NOAA, and NADP; the creation and updating of educational resources, curriculum, and projects; and overseeing the many different activities that occur at the Forest annually.

As a result of insufficient funding and an overburdened staff, the Consortium has not always been able to offer all the resources that they desire to make available. An example of an area in which the Forest's vision is not fully met is the Forest's website.

The World Wide Web has greatly expanded the scope of scientific, cultural, and educational organizations, allowing them to reach increasingly larger audiences as they enhance distribution, access to information, communications, and collaborations. (McClintock, R. 1997) As a result of the numerous benefits of having a website, it would be highly unusual for an organization such as the Black Rock Forest Consortium to exist without a Web presence. The Black Rock website can be found at http://www.blackrockforest.org. The website provides basic information on the Consortium's activities and encourages individuals to contact the Forest in order to obtain more information. The web site is divided into 4 major sections; which include, Consortium, Forest, Research and Education. The Consortium link includes, the Consortium's mission statement, membership list, Forest staff information, a list of board members, information on research grants awarded by the Consortium, giving information, and recent issues of the Forest's newsletter available in a .pdf format. The research section of the website contains, a list of ongoing research projects along with

email information for contacting scientists, a data submission form with protocols for submission and metadata inclusion, a sample of the Data Harvester, and information on the Forest's small grant program. The education section of the website makes available information on instructional programs offered by the Forest, and a list of some of the classes that are offered through Consortium member institutions. The Forest section includes the Forest's usage policy, information on the geology and topography of the Forest, a history of the Forest, and click able maps. The Consortium has established partnerships and many of these partnerships are visible through the website in the form of links. Links are included to several monitoring stations and partnering organizations.

As it exists today, the website does not allow visitors to download Forest publications, curriculum, activities for learners, and currently has no real edifying benefits. Currently, access to dynamic projects occurring at the Forest such as the Data Harvest Environmental Monitoring Project has to be accomplished through the assistance of a Consortium member institution or through a physical visit to the Forest's Center for Science and Education. Additionally, many of the Consortium member institutions have created educationally enriching projects that are available online, however; no links are provided to these resources. As a result of these shortcomings, the dispersal of projects and learning resources to educators and learners that are not members of the Consortium is severally limited.

For several years Consortium representatives have noted the limitations of the website; however, a lack of funding and staffing has prevented significant growth and changes from taking place. Because many of the activities that occur at the Forest or are organized by Consortium member institutions as well as curriculum and research data are

not noted on the website, a proposal is in place to introduce improvements to the website.[188] Improvements are designed to make access to environmental monitoring sensor data instantaneous, as well as include live digital images. A major goal is to eventually make the Forest's database of research publications, papers, and archival data available via the website; as well as, new papers, the results of current studies, and curriculum.[189] [190] However, the continual problem will be the constant need to update and maintain the website. The current proposal seeks to put much of the responsibility for the updating and maintenance of the website out of the accountability of Forest staffers and place it into the hands of the Columbia Center for New Media in Teaching and Learning in New York City. We will see as the future unfolds the success and or shortcomings of the proposed improvements as well as the results of shifting website responsibility from Forest staffers to instructional technologist at CCNMTL.

The Consortium's website serves as an example of one way in which inadequate funding and a lack of staffing are a major hindrance to the Consortium's growth. At the same time, the current proposal which seeks to address funding issues for the website, illicit manpower from CCNMTL, allow for upgrading of technology, and place the website in the hands of instructional technology experts; serves as an example of one way in which the Consortium can seek to resolve their shortcomings now and in the future.

As the Consortium continues to evolve it will be faced with demands that will require it to make choices. These choices center around the need for funding to meet the demands of the public as well as the needs of Consortium members, financing for

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[188] Shuster, W. (2002). *Modernization and expansion of the Ecosystem Monitoring Network for scientists, students and educators at the Black Rock Forest field station.* Unpublished Proposal. Cornwall, NY: Black Rock Forest Consortium.

[189] Kimble, A. (personal interview, 2000).

[190] Kimble, A. (personal communication, 2000) Black Rock Forest Technology Needs.

increased staffing, and a desire to incorporate more underserved educational institutions. As a result, the Consortium will need to be resourceful in its attempts to raise funding. Although increasing membership dues may appear a likely solution, this action may threaten participation in the Consortium by making membership cost prohibitive for underserved institutions. Extending the number of members is also a viable option for consideration, but then the question arises, who should be invited for membership in the Consortium? A new program addresses both of these concerns. Recently grant funding from the New York Community Trust has enabled the introduction of the School in the Forest Program, which raises the number of members while allowing for membership by underserved populations that would not otherwise have been able to pay the requisite dues.

The Consortium has been very successful over the years in procuring grant monies. Grants have been obtained from corporate entities, educational institutions, science and cultural organizations, philanthropic organizations, as well as through government programs. It is crucial that in the future the practice of grant writing not only continues but grows.

In the past the Consortium's fundraising efforts have not been aggressive even though fundraising can be crucial to the existence and growth of non-profit organizations. It is important that the Consortium explore making new inroads in this area through the launch of a well-planned and aggressive fundraising campaign that seeks to reach the public and private arenas as well as appeals to the scientific, educational, and local communities.

Obtaining grants and conducting fundraising both require considerable manpower, an area in which the Forest is already lacking. As a result, it may become necessary for the Consortium to elicit volunteers from member institutions and the local community to assist in these efforts. The very same community that so aggressively fought to save Black Rock Forest from degradation at the hands of Consolidated Edison should be able to be convinced through appropriate pleas to aide the Consortium in its efforts to steward the Forest, assist scientists in environmental studies, and enrich education by supporting and creating programs that help to link learners to the scientific process.

Summary

The focus of this narrative, the Black Rock Forest Consortium, is based upon a spectacular landscape that rises high above the tumultuous Hudson River in the majestic highlands and is a historic and once pristine landscape -- a splendid example of America's rapidly disappearing natural wonder. Recognizing the need for environmental conservation and wildlife preservation, research and education, the Black Rock Forest has been protected by a permanent land trust and is part of an innovative consortium consisting of public and private K-12 schools, major public and private universities, and several science and cultural institutions.

The Black Rock Forest Consortium is a unique organization of diverse institutions that for 15 years have collaborated to participate in activities that support ecological conservation, wildlife preservation, scientific research, and education. As a result, an amazing amount of activity has taken place among Consortium members allowing for

interesting connections to be created that help to link teachers and learners to science research through the creation of educational projects that take the teaching and learning of science outside of the textbook and expose students to the scientific process by having learners play the role of actual practicing scientists.

The Forest has received much notoriety as it has served as an exemplar and model as a field station, an information network, and an intellectual resource that works to bridge the gap between scientific practice and education. The Consortium recognizes the importance of environmental studies and increasing the understanding of the scientific process. It has never wavered from its commitment to enhance education, working on teacher training, experimental education, curriculum development and delivery, field trips and other hands on activities, access to data, increasing exposure to the scientific process by expanding access to actual working scientists and encouraging participation in real scientific research. Most of the educational projects have been developed are a collaboration between Consortium member institutions as assisted by Forest staffers. Many of these projects have received public and private grant money to assist in their formation. Although the projects that have been created could have been introduced without the assistance of the Consortium, it was certainly Black Rock that served as the stimulus, laboratory, launch pad, nurturer, and supporter.

The educational projects that have been created illustrate that the Consortium has been successful at fulfilling its mission statement. In particular its goal to serve as A Center for Research and Education that:

> "Promotes scientific study of the organisms, environment, and interacting processes within natural systems. Foster research access to the environmental effects of human activities upon the integrity and stability of the biosphere. Build a community for scientists and educators among the member institutions with the

> goal that educational programs be based in real science... Use the Forest as a model site for learning basic scientific principles emphasizing an experimental approach and fostering investigative and problem solving skills."

The pedagogical implications of the Black Rock Forest are profound. The study of science is an active process.[191] Increasingly more and more educators are recognizing the pedagogical benefits of making all learning an active process. Scientific study requires individuals to hypothesize, explore, discover, evaluate, analyze, conclude, create, and collaborate. The ability to make correlations to think at different levels has implications in a host of academic areas as it encourages analytical and critical thinking.

By learning through the understanding of real scientific data collected from nature representing actual earth processes students are able to experience anchored instruction where effective learning involves knowledge being contextualized or embedded in meaningful narrative metaphors, resented in multiple perspectives, and situated in problem-solving learning scenarios. Black Rock has made important inroads in the creation of educational projects that use real data and engage students in the scientific process and the edifying projects that have been created through the Black Rock Forest Consortium show the value of collaborations between scientists and educators.

The Black Rock Forest Consortium illustrates that a group of institutions can band together to protect and conserve our natural resources for future generations, utilizing them for research, recreation, conservation, and education. As the Consortium evolves it will continue to face a need for additional funding and greater staffing to meet demands. This is something that an organization that seeks to ensure diverse membership

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[191] Kim Kastens refers to science as a verb. Kastens, K. (1995). Earth Science as a vehicle for illuminating the boundary between the known and the unknown. *Journal of Geological Education,* v.43, p.138-140

through low dues is bound to face. As a result, the Consortium will be forced to seek new resources through such activities as grant writing, fundraising, and volunteerism.

CONCLUDING THOUGHTS

The examination of the Black Rock Forest Consortium can stimulate our thoughts because diverse collaboratory organizations have enormous potential today and in the future. By banding together groups are able to expand resources, enlarge their intellectual weight and potential, bridge gaps between practitioners and learners, develop new ideas and projects, combine talents, reach larger audiences, and offer expanded services. Consortiums can and do increase communications and collaborations, enhance publishing capabilities, and encourage the greater distribution of resources across socio-economic/ geographic lines. With this in mind, I believe that collective potential is greater than individual talent and hope that in the future more and more organizations will see the benefits of becoming part of collaboratory consortiums.

Mr. Golden attributes much of his vision for the formation of the Consortium to the University Commission for Atmospheric Research (UCAR) an organization that was formed to share the resource of a valuable telescope a resource that may have been unattainable without a partnership. Mr. Golden was able to transfer the UCAR concept to his idea to form a Consortium dedicated to stewarding a valuable environmental resource as well as creating links between scientific practice and education.

It is important to avoid narrow sightedness and rather look at the far-reaching implications of collaborative consortiums. In the future I am hoping that increasing numbers of groups will see that the benefits of these type of organizations is not limited

to the scientific community but rather have fantastic implications for a host of areas such as music, literature, history, cultural appreciation, the creative arts, medicine, and etcetera, areas in which the benefits of collaboration and the expansion of resources may be invaluable.

In the area of science education, the goal is to take science learning away from the pre-packaged lab and decontextualized textbook-based lessons and transform science education by linking science study to scientific practice. Bridging the gaps between learners and scientists is done through the use of real data, hands-on experimentation, the examination of working systems, modeling, and access to actual working scientists. (Kastens, K. 1997) Successfully blending scientific practice and science education is best accomplished with the establishment of collaborations between the professional and educational arenas.

The example provided in this narrative, the Black Rock Forest Consortium, illustrates that collabroatory organizations can help bridge gaps between learners and practitioners. The Black Rock Forest Consortium has been successful in helping to create enriching educational endeavors that encourage learners to implement the scientific method and take the role of professional working scientists.

Hopefully the narrative provided will build interest in collaborative consortiums and help serve as an example of one successful group that has developed a diverse membership, been successful at creating projects and seeking funding for these projects, overcame many obstacles in its formation, and has managed to thrive for a decade and a half while facing the daily struggles to overcome financial and staffing needs.

The formation of a consortium is not a small undertaking and often involves a lengthy and arduous process. Not only is a vision and mission necessary, but so is leadership, a willing membership base, a resource worth sharing, patience, commitment, and funding to get off the ground. Legal issues, politics, potential member concerns, staffing, funding, as well as rules and regulations play a major role in the creation process. Additionally, once formed a consortium may face some of the same issues that are of concern to Black Rock.

Every consortium that is formed will have unique goals, concerns, needs, and shortcomings, and all will tackle these concerns in a way befitting their organization and its membership base. What is important to understand is that a consortium can work, be successful, and thrive for future generations. To build on a metaphor originally presented by Mr. William Golden, the founder of the Black Rock Forest Consortium, the desire when forming a collaborative consortium is to plant a tree which will need to be nourished in order to grow and that will hopefully grow quickly, live long, and be plentiful.[192]

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[192] Golden, W. as qtd in Foderaro, L. (1989, August 25). Harvard will sell a forest, a legacy from an alumnus. *New York Times*.

HOW I DID THIS STUDY

The Black Rock Forest Consortium is an unusual collaborative organization comprised of scientific and cultural institutions, universities, and K-12 schools. The Consortium's mission is to enhance scientific research, conservation, and education, and my goal in documenting the formation of the Consortium is to help provide inspiration and suggestions for future similar collaborations.

The purpose of this case study is to document the formation of the Black Rock Forest Consortium and to offer examples of the projects that depict how the collaborative nature and unique make-up of the Consortium is helping to bridge gaps between scientific practice and science education.

In order to create a historical narrative of the Consortium I needed to start at the beginning and examine records relating to the geological and cultural history of the Forest and surrounding region. These records were acquired through library and community resources, reviews of studies and other reports, Forest publications, and through the assistance of Forest representatives who eagerly opened their archives. Once a cursory overview of the geologic and cultural history of Black Rock had been established it became imperative to focus on the Stillman family legacy as well as Harvard's Tenure with the Forest.

I began my study of the Stillman legacy and Harvard's ownership within the archives of the Golden Family Foundation. The Golden Family Foundation had diligently

kept a record of all memos, minutes, letters, correspondence, newsletters, proposals, literature, articles, and publications pertaining to the Forest. As a result of the information obtained through the Golden Family Foundation the story of Black Rock emerged and I was able to formulate a game plan that included a list of publications and individuals who would help me gain additional insight into the Stillman legacy as well as the Harvard years. I interviewed key figures dating back to Harvard's ownership of the Forest, which included Jack Karnig, former Forest Manager, and Daniel Steiner, former Vice President and General Council of Harvard.

Through the study of the Stillman years along with Harvard's dealings with Black Rock the importance of the Consolodated Edison Controversy became apparent. To study the Con-Ed Controversy I reviewed the original Con-Ed proposal, the official report released by the committee organized to study the proposed action, the numerous articles published throughout the lengthy debate, and memos written by Mr. Golden. I re-interviewed representatives from Harvard and the Forest from the time of the Controversy as well as had discussions with William Golden and Helene Kaplan who were directed by Daniel Steiner to develop a proposal for future use of the Forest.

During the course of the previous investigation a list emerged of individuals relevant to the movement of the Forest from Harvard to the Golden Family Foundation, the formation of the Consortium, the financial transaction and lease agreement, the Stillman endowment, and the growth of the Consortium. Many of these individuals had remained in contact with the Consortium while several had moved on years earlier and required a certain amount of sleuthing to find. These figures were contacted in person whenever possible, via phone, through written correspondence, and via email. A

questionnaire was developed that included open-ended questions. The questions were approved by the Institutional Review Board of Teachers College. The questionnaire asked respondents: how they first became involved with the Forest, their role and affiliation with the Forest, their role with the transition of the Forest from Harvard to the Consortium, their role with the formation of the Consortium, obstacles to the formation of the Consortium, the strengths and weaknesses of the Consortium, how the Consortium has evolved over the years, how if applicable the Consortium has been beneficial to them and or to the organization they represent, how if at all is they feel the Consortium is unique, and their predictions for the future of the Consortium. Questionnaires were distributed via mail and email to all listed Consortium member representatives, Forest staffers, as well as Consortium board members. In some instances usually under the request of the respondent individuals participated through phone interviews, many of which were recorded. Although not all individuals contacted choose to respond the responses gained were valuable. The questions were examined and responses to individual questions were divided thematically. In order to gain further insight several of the individuals who had participated were re-interviewed to allow for deeper inquiry.

In addition to interviews, archival information was reviewed, which included articles and editorials, Forest publications, minutes from meetings, memorandums and correspondence, Forest newsletters and news reports. This information was collected directly from the Forest and from the files of several institutions and individuals.

While conducting the examination of the history of the Black Rock Forest Consortium the goals of the Consortium became clear and a theme emerged. The theme as I saw it was a desire to help link scientific practice and science education by making

access to scientific data, the scientific processes, and scientific practices more available to educators and learners. As a result, I began examining the projects that have developed through the Consortium and its member institutions that help to bridge the gaps between scientific practice and science education. In order to conduct an investigation of the Forest's educational programs that I thought were sound examples of how a collaborative Consortium can help create greater linkages, I reviewed grant proposals, project plans, reports, curricula and publications, as well as conducted discussions with relevant individuals from the Forest, Barnard College's Institute for Urban Education, Lamont Doherty Earth Observatory, the Center for Environmental Research and Education, and the Columbia Center for New Media in Teaching and Learning. Individuals were contacted in person, via the phone, and through email.

All individuals contacted as part of this case study were asked to sign a consent form (see appendix) and the use of human subjects was approved by the Teachers College Institutional Review Board. When obtaining written permission for participation was not possible individuals were asked to voice their permission during recorded phone interviews. Individuals whose signatures or vocal approvals I was not able to obtain were not quoted or included in this document.

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APPENDIX A

CONSENT FORM

FOR QUESTIONS ABOUT THE STUDY, CONTACT: Nicole Antoinette Buzzetto
200 East 90th Street, Apt 6H
New York, NY 10128
212-876-3023
nab23@columbia.edu

DESCRIPTION: You are invited to participate in a research study on the history of the Black Rock Forest Consortium and the evolution of the Virtual Forest Initiative. You will be asked to describe your role in conjunction with the above mentioned organizations. Your responses may be recorded on audiotape. Your responses may be quoted and used in the writing of this case study.

RISKS AND BENEFITS: There are no foreseeable risks and or benefits for participating in this study.

DATA STORAGE TO PROTECT CONFIDENTIALITY: Unless requested you may be quoted; however, at the request of participant subject confidentiality can be preserved. Data will be stored at the home of Ms Buzzetto. All audiotapes will be stored at the home of Ms. Buzzetto and destroyed following the completion of this study.

TIME INVOLVEMENT: Your participation will take approximately one hour.

PAYMENT: You will not receive any payment for your participation.

SUBJECT RIGHTS: If you have read this form and have decided to participate in this project, please understand that your participation is voluntary and you have the right to with draw your consent or discontinue participation at any time without penalty. You have the right to refuse to answer particular questions. You agree and understand that your identity will be made known in all written data resulting from the study. You also agree to allow audiotaping of your participation.

IRB CONTACT INFORMATION: If you have any questions about your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact- anonymously, if you wish- the Institutional Review Board at Teachers College, Columbia University, 212-678-4105 or 525 W. 120th Street, New York, NY 10027 Box 151.

SIGNATURE STATEMENT: All of my questions have been answered to my satisfaction by the investigator. I consent to participate in the study described.

SIGNATURE: _____ **DATE:** _____

APPENDIX B

SELECTED BIBLIOGRAPHY FROM RECENT PUBLICATIONS BASED ON RESEARCH CONDUCTED AT THE BLACK ROCK FOREST

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*A complete list of the more than 300 research publications that have occurred as a result of research conducted at the Black Rock Forest is on file at the Forest headquarters and is available upon request. Contact blackroc@ldeo.columbia.edu, or visit www.blackrockforest.org, or call 845-534-4517.