



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2006 Volume I: Photographing America: A Cultural History, 1840-1970

The Photographed Environment in America

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Introduction

The majestic Yosemite Valley in California is photographed from Inspiration Point: El Capitan, Bridal Veil Falls, Cathedral Spires, and Half Dome are seen in the distance with the Merced River Valley below. The year is 1865 or 1866. Over the course of the next decades, American tourists and foreign visitors to the United States will visit this and other national parks in growing numbers. Within the half-century, voices of alarm will be raised as the unique natural features that made these parks worthy of protection are increasingly threatened by commercial misuse and recreational overuse.

The tallest and the most massive trees on Earth- the Coast Redwoods and the Giant Sequoias of Northern California -- are seen in photographic images by disbelieving Eastern eyes in the 1850s and 1860s. Through the nineteenth century and the first part of the twentieth century, those who would preserve these big trees for future generations met opposition from those who saw the trees as a valuable source of lumber. The establishment of Kings Canyon National Park in 1939 assured protection for some of the most significant stands of sequoias. By the year 2000, however, more than 80 per cent of all Pacific Northwest old-growth forests have fallen to the insatiable axe and saw.

Some forty thousand hides from slaughtered buffalo are piled high in a commercial yard in Dodge City, Kansas in 1878, midway through the late nineteenth century's all-out effort to exterminate the many millions of American Bison from North American plains and woodlands. The buffalo's last minute rescue from extinction begins in the 1890s, and a concerted effort to restore it to viable numbers meets with success. This keystone species of the plains now numbers in excess of 350,000 buffalo in public and privately owned populations. An agricultural industry has developed based on the sustained use of buffalo meat and buffalo products.

Muir Glacier in Alaska is pictured in 1941 as an advancing conveyor belt of ice. Seen again in 2004 amidst concern about global warming, it is more accurately described as a feeder of melt water to a deep glacial lake. Eleven million gallons of crude petroleum oil seep from the Exxon Valdez supertanker after it runs aground in Prince William Sound in March 1989, and thirty thousand birds and at least 3500 sea otters die and wash on shore with oil-caked feathers and fur. The total cost of the cleanup and settlement of actual and punitive damages caused by this oil spill approaches \$10 billion.

Each of the above stories is an example of an historical or a contemporary environmental issue that may be studied through the use of photographs. This curriculum unit presents a brief history of the environmental movement in America from the 1840s to the present. The unit relies on the close analysis of nineteenth and twentieth century photographs to examine America's changing worldviews of our natural heritage and how we choose to use our lands and natural resources. These visual images, identified from several easily referenced photographic archives and from photography books, introduce a series of topics that one studies in a high school environmental science course. Included among these topics are the exploration of the American West, the extraction of natural resources from the land and the sea, the exploitation of and subsequent efforts to restore and protect wildlife in America, the harmful impacts of indiscriminate use of toxic chemicals by agriculture and industry, and the degradation of the country's air, land, and water.

The photographs cited in this unit have been chosen to provoke thought and promote discussion about environmental topics. They are central to the unit's narrative description of key events in the American experience with nature, as well as to the various classroom activities that my students will conduct. In addition, the unit identifies key historical figures in the environmental movement and makes reference to some of their more important writings about nature. My intention is to portray a nation that continues to seek a workable definition of the relation between the economic and the ecological benefits of nature.

Unit Objectives

The objectives of this unit are:

1. To use historical and contemporary photographs as educational tools for the immediate experiencing of important topics in environmental science. Among the environmental topics that are evidenced in photographs and that are available for description, deduction, and speculation are: the sustainable and unsustainable use of natural resources; species endangerment and extinction; the atmosphere and air pollution; water and water pollution; toxic waste problems; solid waste disposal; land use and the development of a land ethic; people's attitudes about land protection;
2. To promote the development of observation skills through the close examination of photographs for their contained information and their multiple meanings;
3. To engender a familiarity with some of the more famous and not so famous visual images associated with the development of an American environmental consciousness;
4. To develop a brief history of the environmental movement in the United States;
5. To discover through photographs the beauty of the natural world and also recognize its fragility;
6. To make connections between a catalogue of photographs and some of the important writings in the environmental sciences from such writers as Henry David Thoreau, George Perkins Marsh, John Muir, Aldo Leopold, Rachel Carson, and Edward O. Wilson;
7. To reinforce a moral position about the environment and help build a nascent one (in the words of writer Susan Sontag);
8. To assist in preparing students for the national College Board/Advanced Placement

Unit Strategies

I have examined a number of collections of photographic images available on line from such sources as the National Archives, the New York Public Library Digital Gallery, the J.Paul Getty Trust, the George Eastman House Still Photograph Archive, the Bettman Archives, and various state libraries and historical societies. On the basis of these reviews of photographic archives, I have assembled a collection of digitized photographs of value in the study of the environmental sciences. I use current technologies to project these images for examination by my environmental science students as they consider contemporary environmental issues. In selecting these topics in the environmental sciences, I have referred to *Living in the Environment* (Twelfth Edition) by G. Tyler Miller (Thomson, Brooks/Cole), the text book used in the Advanced Placement Environmental Science course that I teach to high school eleventh and twelfth grade students. Chapter 3 of the Miller text is entitled "Environmental History: Learning from the Past."

The overview of the American environmental movement that is provided below suggests a broad array of topics for which photographs can be used to introduce students to the environment and to generate discussion and interest. I list some specific examples of photographs that I will use to introduce environmental topics and concepts to my students. I anticipate that in the future I will expand this unit to include photographs in the following areas of the environmental sciences: land protection (national parks, national forests, and wilderness areas); extraction of natural resources (mining, lumbering, whaling, sealing, fishing); energy issues (nuclear testing, nuclear power plants, alternative energy sources); solid waste disposal (landfills, tire graveyards, recycling efforts); chemical contamination (effects of chemical pesticides and insecticides); environmental disasters (oil spills, waste lagoon leakages, fish kills, landfill contaminations, heavy metal poisoning, Superfund sites, dumping waste at sea); population issues (unequal access to basic resource needs, disease, famine, and death); pollution (air, water, and land); habitat degradation (soil erosion, desertification, wetland destruction); wildlife endangerment (direct exploitation, predator control measures, international trade in endangered species); political activism (Earth Day events, protest against use of nuclear power, the Sagebrush Rebellion); global issues (global warming, ozone depletion, acid precipitation).

Drawing on information about the American environmental movement from the sources listed below, this curriculum unit offers a careful selection of photographs to create interest in these environmental subjects. It is my hope that the selected photographic images will grab my students' interest, will "blow their socks off." As noted in the Unit Objectives, I attempt to have my students develop the ability to gather the evidence

contained within photographs, to read their multiple meanings, and to develop moral stances concerning the environmental issues. There are three approaches to the photographs that must be made. They are to identify clearly the subject matter of each photograph, to regard each image as a work of art, and to interpret the ecological, geological, and environmental significance of the photograph. I project each photograph in the classroom with a brief introduction to the subject matter of the photograph or with my assessment of what the photograph shows. For example, the early photographs of Yosemite Valley are documentary landscape photographs that provided Americans a first introduction to this extraordinary valley. The piles of buffalo hides are an example of direct exploitation of a wildlife resource. The giant trees of the Pacific Northwest represent old-growth forest, one of the most vulnerable and threatened habitats in the world.

As works of art, photographs are characterized by their composition and framing, the angle of perspective, the use of light and texture, and the attention given to geometry. As evidence for concepts and principles in the physical and life sciences, the photographs can be read for their scientific content. My ultimate goal in using photographs to teach topics in environmental science is to create in my students a distinct memory for each class period. To do so, I place far greater emphasis on encouraging and developing student comments about the photographs than in lecturing or in providing more than a brief introduction to the photographic images.

Throughout the unit I make use of photographs that are paired with each other based on subject matter, artistic content, or scientific significance. I allow a significant amount of time for my students to study and discuss the first photograph in each paired group. I then project the second photograph for comparison. The pairs of images that I have selected for use typically were made by different photographers and at widely separated time periods. I am looking for, and I want my students to perceive changes - changes in people's attitudes toward nature, in the physical and biological compositions that necessarily ensue in natural areas, and in environmental health and well being. This is accomplished by posing a series of questions to my students. What is the subject matter of the photograph? How does the photographer represent the scene? What is its environmental significance? (Let's get this out on the table as quickly as possible.) What were the fundamental meanings of the photograph when it was created, and what are the meanings today? What is the photographer's attitude about what is being depicted? What can be said about the composition of the photographic image? How is light used, and texture, perspective, angle, geometry? What is your personal reaction to the photograph? How does it compare with the image with which it is paired? Are these photographs of lasting value in thinking about environmental issues or when considered strictly as works of art?

Susan Sontag writes in *On Photography* (1977), "photographs are valued because they give information. They tell one what there is: they make an inventory." She further states that "photographs were seen as a way of giving information to people who do not take easily to reading." I preface many of the sections that follow with additional quotes from Sontag's *On Photography* as it is a wonderful source of insights about photography and the natural and human-altered environments.

A Brief History of the American Environmental Movement

The Miller environmental science text describes three cultural revolutions that have characterized the known history of human society, including: (1) the agricultural revolution of 12,000 to 10,000 years before present, in which wild plants were first cultivated through slash and burn and shifting cultivation technologies and wild

animals were first domesticated; (2) the industrial-medical revolution beginning approximately in 1750 in England and 1800 in America, in which Western societies developed a dependence on nonrenewable fossil fuels (coal, oil, and natural gas), cities were established, large-scale production of manufactured goods occurred, and the human population increased dramatically, and; (3) the information and globalization revolution, beginning after World War II and still underway, in which fast and near-instantaneous sharing of information has transpired and environmental degradation (habitat destruction and biodiversity loss) has become readily apparent to those who discern.

Miller further describes the American odyssey of environmental developments and recognizes tribal, frontier, conservation, and environmental components to our environmental history. The text has sections on "the early conservation era" and its three subdivisions of 1832-1870 (with reference to Henry David Thoreau and George Perkins Marsh), 1870 to 1930 (John Muir and Theodore Roosevelt), and 1930 to 1960 (Franklin D. Roosevelt's federal programs and Aldo Leopold) and then the modern "environmental era" of 1960 to present (Rachel Carson, Paul Ehrlich, Barry Commoner, and Garrett Hardin). In addition, there is discussion of two case studies: the "Near-Extinction of the American Bison" and "Aldo Leopold and His Land Ethic." A highly useful appendix lists "Major Events in U.S. Environmental History" from the 1872 establishment of Yellowstone National Park (the first designated national park in America and in the world) to the 1992 International Convention on Biological Diversity (United Nations Environmental Summit at Rio de Janeiro, Brazil), the 1997 writing of the Kyoto (Japan) Protocol dealing with issues of global warming, and the 2001 United Nations International Panel on Climate Change (IPCC).

This curriculum unit also has been influenced by my readings of several histories of the environmental movement in America, including John McCormick's 1989 book, *Reclaiming Paradise: The Global Environmental Movement*, Donald Worster's 1994 book, *Nature's Economy: A History of Ecological Ideas* (second edition), and Roderick Nash's classic 1982 book, *Wilderness and the American Mind* (third edition). Each of these environmental histories provides considerably more information about the history of American (and global) environmentalism than can be found in a general text about environmental science. I refer here to McCormick's environmental history (read most recently), but I could equally well have used the Worster and Nash books to provide a brief overview of environmentalism in America.

McCormick defines environmentalism as being "fundamentally concerned with the protection and management of the natural and human environment." Environmentalism combines scientific, economic, social, and political issues. McCormick has his own delineation of periods in the environmental movement during which our views of critical environmental issues have broadened and matured. These periods are best identified by McCormick's chapter headings, and they include: (1a) "The Roots of Environmentalism" - the mid-nineteenth century and the twentieth century up to 1945, which saw the beginnings of a philosophy of man and nature, inspired by Romanticism and the writings of George Catlin, Ralph Waldo Emerson, Henry David Thoreau, George Perkins Marsh, and John Muir (the wilderness preservationists); (1b) a parallel development of resource conservationists, including Gifford Pinchot, Theodore Roosevelt, and others who felt that existing natural resources should be used in non-wasteful ways in development for the benefit of the many; (2) "Protection, Conservation, and the UN" -- from 1945 to 1961, the maturation of the ecological sciences and the development of a land ethic by Aldo Leopold (*A Sand County Almanac and Selected Essays*); other important books on environmental issues were written by Paul Sears (*Deserts on the March*), Fairfield Osborn (*Our Plundered Planet*), and William Vogt (*Road to Survival*); this period is also defined as the post-World War II emergence of a "true environmental revolution" in which governmental and intergovernmental organizations were formed and treaties and agreements on environmental issues were signed; (3) the "Environmental Revolution" or "New Environmentalism" of 1962 to 1972, during which the focus changed to concern about the

human environment and such issues as economic development, population growth, and equity in the distribution of resources; (4) an overlapping period (1968-1972) in which the writings of the "prophets of doom" were widely disseminated, especially those publications by Paul Ehrlich (*The Population Bomb* , 1968), Barry Commoner (*The Closing Circle* , 1971) and Garrett Hardin (the *Science* article, "The Tragedy of the Commons", 1968).

Further chapters in McCormick's book include (5) "The Stockholm Conference (1970-1972)" -- considered by McCormick to be a "landmark event" in the development of environmentalism as an international issue of concern to humanity; (6) "The United Nations Environment Programme (1972-1982)" -- a UN program set up to research and monitor environmental issues (Earthwatch), provide environmental protection (e.g., the Convention on International Trade in Endangered Species and Endangered Species Products, CITES), and provide public information and education on the environment (Earthscan); (7) actually Chapter 9 "The Global Environment" (from 1982 to publication of the book) -- during which important global treaties were signed on such environmental topics as wetlands (the Convention on Wetlands of International Importance (RAMSAR Convention), world natural and cultural heritage (Convention Concerning the Protection of the World Cultural and Natural Heritage), endangered species (CITES), and migratory species (the Migratory Species Convention (Bonn Convention)). As suggested by the sections on the Stockholm Conference and following, American environmental issues were now being viewed in the context of world environmental concerns.

A series of widely publicized natural disasters that occurred in the second half of the twentieth century galvanized the modern American and international environmental movements. Among these human-caused disasters, McCormick refers to: the 1948 occurrence of a sickening and killing cloud of sulfurous acid at Donora, Pennsylvania; the 1956 Minamata Bay, Japan mercury contamination of fish and the resultant neurological damage to the human population (Minamata Disease); the 1967 wreck of the Torrey Canyon oil tanker off the southwest coast of Britain; the 1969 blowout of an oil platform at Santa Barbara, California; the 1970 fire that ignited in the Cuyahoga River near its merge with Lake Erie in Cleveland, Ohio in which the river remained on fire for many days; the 1976 contamination of Love Canal, New York by industrial chemical wastes that led to the evacuation of an entire community and federal purchase of the land; the October 1976 nonviolent protest against nuclear power at Seabrook, New Hampshire; the March 1978 Three Mile Island (Harrisburg, Pennsylvania) nuclear accident; the May 1979 demonstration in Washington, D.C. of 75,000 activists against nuclear power; the April 26, 1986 Chernobyl nuclear power station disaster; the December 1984 Bhopal, India incident.

McCormick's history includes discussion of a change in human attitudes about the environment, the development of a popular, global mass movement, concern about nuclear testing and radioactive fallout, advances in scientific knowledge, and the relation between the environmental movement and other social movements such as those for civil rights and the antiwar movement. His calendar of significant events in the history of the American environmental movement includes in the nineteenth century: the publication of Marsh's *Man and Nature* (1864), the transfer of the Yosemite Valley and the Mariposa Grove of Big Trees from the federal government to the State of California (1864), the formation of the world's first national park, Yellowstone National Park in Wyoming (1872), the transfer of Yosemite Valley back to the federal government and the establishment of Yosemite National Park (1890), and the formation of the Sierra Club (1892). In the twentieth century, significant events in the American environmental movement cited by McCormick include: the mid-1930s Dust Bowl of the Great Plains States; publication of Aldo Leopold's *Game Management* (1933) and *A Sand County Almanac and Sketches Here and There* (1949); Rachel Carson's *Silent Spring* (1962); Stewart Udall's *The Quiet Crisis* (1963); the first photographs taken from space of the entire Earth (1966); the world's first Earth Day, held on April 22, 1970 and sponsored by Senator Gaylord Simpson; Paul Ehrlich's *The*

Population Bomb (1968); Barry Commoner's *The Closing Circle* (1971); Donella H. Meadows et al. *The Limits to Growth* (1972).

The discussion that follows provides examples of how photographs may be used to teach the fundamental concepts of environmental science.

The American Landscape

"Faced with the awesome spread and alienness of a newly settled continent, people wielded cameras as a way of taking possession of the places they visited." (*On Photography* , page 65)

"Nature in America has always been suspect, on the defensive, cannibalized, by progress. In America, every specimen becomes a relic." (*On Photography* , page 65)

Photographer Carleton Emmons Watkins (1829-1916)

IA. *The Yosemite Valley from Inspiration Point* (Yosemite Valley, California: created date ca. 1865-66; New York Public Library Digital Gallery, Digital ID: 435022; albumen print)

Photographer Ansel Adams (1902-1984)

IB. *Moon and Half Dome* , 1960

The grandeur of Yosemite Valley was documented photographically by Carleton E. Watkins, Eadweard Muybridge, Timothy H. O'Sullivan, William Henry Jackson, and other important landscape photographers of the mid-nineteenth century. Their photographs contributed to the establishment of Yosemite as California's first state park in 1864. The return to federal jurisdiction of what then became Yosemite National Park followed several decades later. In the Watkins photograph that I have selected for use, the Valley is seen from Inspiration Point, appropriately named for the visitor to the Valley and for the viewer of the photograph. The rocky foreground gives way to a forested descent into the valley, and it draws the viewer into the scene. The picture is well framed by the rocky outcrop on which the photographer stands, by tall trees at the left and right, and by an undistracting, blank sky. The image beckons one to descend into the valley and follow the meandering river (largely obscured from view) through monolithic valley walls. With such a broad panoramic view, the eyes dart from El Capitan on the left to the Cathedral Rocks on the right, and they inevitably land on Bridal Veil Fall. A careful examination of the photograph reveals Half Dome in the hazy distance, beyond Glacier Point. Valley slopes are tree-covered, yet more barren areas suggest a significant degree of geological instability. The classical U-shaped valley carved by advancing and retreating glacial ice creates the image of

massive ice flow in the geological past. In the present day as comprehended in ecological time, the meandering Merced River shapes and reshapes the valley floor. There is an intense geometry to this photograph, with the verticality of large conifers and the near-verticality of valley walls and Bridal Veil Fall. Rounded boulders in the foreground mirror Glacier Point and Half Dome in the distance. Triangular wedges of green extend from cliff faces to valley floor, positioned at right angles to the conical trees. The Sierra Nevada's Yosemite Valley is larger than life, yet it is no more than seven miles long and one mile wide. A 1958 U.S. Geological Survey map tells "The Story of the Yosemite Valley," as written by F. E. Matthes, in which one discovers "a chasm renowned the world over for its towering cliffs, its stately trees, and its delightful climate, but, above all, for its sublime waterfalls."

Ansel Adams created photographs of the Yosemite Valley from a similar vantage point, but his photograph *Moon and Half Dome* succeeds in conveying a sense of the massive scale of Yosemite Valley while confining its view to the shear wall of Half Dome. Two conifer trees visible in the lower right are most effective in giving a sense of scale. In this photograph, the subtle shades of black, gray, and white create a sublime mood. The moon is seen to rise over Half Dome as though it were a marble just having rolled off the upper slopes of the monolith on its way into the valley below. The moon's craters appear to be replicated in the top surface of the exfoliating Half Dome. The valley wall to the left of the scene is so blackened as to eliminate all detail but for the snow-streaked pinnacle of the cliff. Turn this shadow ninety-degrees, and you have the shadow that defines Half Dome's base. The dusting of snow that edges Half Dome's sinuous flanks is suggestive of experiments conducted in modern turbulence theory. Neither the Watkins view of Yosemite Valley nor the Adams view has people in view. Human figures would seem to present a greater intrusion in the Adams photograph. During Adams's lifetime, Yosemite Valley was transformed by an ever-increasing volume of human traffic. Adams decried the loss of wilderness in Yosemite through most of his years there.

Supplementary Photographs

Photographer Carleton Emmons Watkins (1829-1916)

Yosemite Valley from the Best General View (Yosemite Valley, California: created c. 1865-1866, albumen print, The J. Paul Getty Trust)

Mirror View -- El Capitan, Yosemite (Yosemite Valley, California: created date 1861-1866; NYPL Digital Gallery, Digital ID: 435034; albumen print)

Photographer Eadweard Muybridge (1830-1904)

Falls of the Yosemite. From Glacier Rock. (Great Grizzly Bear.) 2600 feet tall. No. 36. Created in 1872, published in 1873. California State Library, Picture Catalog, Call Number 1992-0051. Published by Bradley & Rulofson (San Francisco).

Photographer Charles Leander Weed (1824-1903)

The Valley From the Mariposa Trail, 1860s (Yosemite Valley, California): Digital ID: 435071, New York Public Library Digital Gallery, Photography Collection, Miriam and Ira D. Wallacj Division of Art, Prints and Photographs/Humanities and Social Sciences Library

Photographer Ansel Adams (1902-1984)

Yosemite Valley, Summer, c. 1936

El Capitan , 1952

Thunderstorm, Yosemite Valley , 1945

Half Dome, Merced River, Winter , 1938

Half Dome and Clouds , c. 1968

The Changing American Forest

"Photographs furnish evidence. Something we hear about, but doubt, seems proven when we're shown a photograph of it." (*On Photography* , page 5)

Photographer Carleton Emmons Watkins (1829-1916)

IIA. *The Grizzly Giant and Mariposa Grove, 33 ft. diam. (Yosemite Valley, California Created 1861-1866; NYPL Digital Gallery, Digital ID: 435051; albumen print);* See also Digital ID: g89f323_005f and g89f323_006f stereoscopic views

And Part of the Trunk of the Grizzly Giant (Mariposa, California)

negative 1861; albumen print about 1866) The J. Paul Getty Trust

Photographer James Balog

IIB. *Giant Sequoia (Sequoiadendron giganteum) , "Stagg," Camp Nelson, California . Photographed 2004.*

Watkins' photograph of this enormous Giant Sequoia tree is one of the early pictures of the most massive tree species on Earth. The tree commands the gaze of the viewer, as it dwarfs the surrounding conifers of the forest, including the adjacent burned out bole of a once equally massive Sequoia. The deceased giant survived for some two millennia before ultimately succumbing to natural disaster. The grizzly appearance of the Giant is the consequence of two millennia of input of energy into wood, as seen in the bole of the tree and in its massive branches. The branches reach out in all directions, and the tree seems capable of leaning forward and snatching up the unwary observer. This wizened giant is showing every bit of its age. The nearby remnant of a giant is snapped off and hollowed out in spite of its inherent qualities of fire resistance and rot resistance. An old hunter with rifle in hand stands at the base of the living tree. Watkins' photographic title refers equally well to this grizzled Californian. (Watkins had particular interest in the imagery of this massive tree with a human subject standing at its base, making several different versions of this scene over a period of years.) Together, the living grizzly giants stand in a gap in the forest created through time by the light-gathering canopy of the huge tree. The human presence in this photograph would be insignificant, were it not for the capacity of man, having discovered this relic of an ancient time, to display it as a champion biological trophy, then fell the tree for extractive use, for its rot-resistant lumber.

Watkins' vantage point for this photograph was necessarily some distance from the base of the tree in order for him to capture in one image its full height. The unobstructed view of the tree may have been the consequence of its having survived the natural fire that claimed neighboring trees. Alternatively, the surrounding trees recently have been logged out of the forest. If so, Watkins must have had an ominous foreboding of the demise of the Giant by a rapacious logging industry. The shorter, younger trees in the photo have a much greater percentage of growth in soft needles. They have centuries of growth ahead of them before they can approach the stateliness and grandeur of the Giant. In this old-growth forest, airy brightness is found above and beyond the giant, while the forest floor is dark and shadowy. One must wonder how the Earth from which this sparsely needled giant springs can nourish and water its great height and girth. This photograph documents the existence of huge trees that Easterners could scarcely comprehend or believe from written narratives.

The massive Giant Sequoia tree in Balog's photograph represents a trophy of a different sort. Here, the trophy hunter is a rope-climbing expert who is in the forest neither to hunt game nor to extract valuable biomass in the form of lumber. The climber is seen early in his ascent of the tree and near the top of a 60-foot-high fire scar, and he is present again having reached his destination in the uppermost crown of the tree. Photographer Balog used more than 400 individual photographs in assembling the composite photo of the "Amos Alonzo Stagg Tree," the fifth largest tree in the world in terms of total volume. The Stagg Tree is the largest Sequoia tree growing on private lands. All Sequoias larger than the Stagg Sequoia are found in Sequoia and Kings Canyon National Parks. The sign at the base of the Sequoia reads, "Giant Redwood Dedicated to/Amos Alonzo Stagg/in his 99th year 1960/Cir 25 DBH Est. Age 3000 Yrs/Jordan Mt. Peak." An All-American offensive and defensive end on Yale University's 1889 football team and the originator of the five-man basketball team, Stagg was called the "grand old man" of college football. He lived to be 102 years old. Dedicating this Sequoia to Stagg recognizes yet another grizzly giant in the forest. The technological advances of climbing and of photography have permitted Balog to produce an image of a massive tree that is as sharp and in scale at the top as it is at the base.

Supplementary Photographs

Photographer Carleton Emmons Watkins (1829-1916)

Section of the Grizzly Giant, 33 ft diameter, Mariposa Grove, Mariposa County, Cal. Digital ID: g89f323_011f, New York Public Library Digital Gallery, Created date 1867-1874, stereoscopic view

Species Endangerment and Extinction

". . . nature has ceased to be what it always had been -- what people needed protection from. Now nature -- tamed, endangered, mortal -- needs to be protected from people." (*On Photography* , page 15)

". . . while an untold number of forms of biological and social life are being destroyed in a brief span of time, a device [the camera] is available to record what is disappearing." (*On Photography* , page 16)

Unknown Photographers

IIIA. *Trail of the Hide Hunters. Buffalo lying dead in snow, 1872.* National Archives No. 79-M-1B-4)

IIIB. *Rath & Wright's Buffalo Hide Yard in 1878, Showing 40,000 Buffalo Hides, Dodge City, Kansas (1878)* (National Archives No. 79-M-1B-3)

Photographers Susan Middleton and David Liittschwager

IIIC. *Wood Bison (1993)*

Photographer William H. Illingworth (1842-1893)

IIID. *Custer With a Dead Grizzly (1874 Black Hills, South Dakota Expedition)* National Archives (1874) [77-HQ-264-847]; South Dakota State Historical Society

Photographers Susan Middleton and David Liittschwager

IIIE. *Grizzly Bear (1991)*

The American Bison is undoubtedly the best-known American example of a large mammal that has been exploited to the point of near-extinction. The buffalo, as it is more commonly called, used to number in the many millions prior to the taming of the West. Its numbers were reduced to a barely viable remnant population through the systematic slaughter of the hide hunters, the U.S. Army, and through the "sport hunting" of travelers on the transcontinental railroad. *Trail of the Hide Hunters*, a photograph that is also labeled "buffalo lying dead in snow, 1872," uses a small number of bison carcasses to communicate the extent of the carnage. The most clearly depicted buffalo lies in the foreground, presenting a death gaze to the viewer, its front legs frozen in panicked stride, its horn curling in the direction of the other dead animals. Immediately above is one of the offending rifles responsible for the slaughter. To the left is a freshly skinned buffalo, its hide stretched across the nearby snow cover. Five additional fallen bison stretch toward the distant background, reflecting the same pattern seen in the first bison's curved horn. The hind quarters of a lone standing individual, dazed and confused, (presumably a bison -- it's hard to imagine it being a horse), suggest that the end is near for this archetypal symbol of the Great Plains. Flensing marks are apparent on the skinned buffalo's flanks, and its naked head lies just left of the second buffalo and the rifle. The vast expanse of the prairie extends to distant hills.

Rath & Wright's Buffalo Hide Yard in 1878 depicts the industrial destruction of the American Bison, with workmen riding in a horse drawn cart, standing beside scaffolding and skinning carcasses, and taking a break from the monotonous work while stretched out on a mound of hides. A medium-sized dog gets petted as the domesticated horses pull alongside. Those mammals that can be tamed serve man's domestic purposes. Those large animals that cannot be domesticated wind up as skins, bleached bones, steaks, and offal. The story takes on a more bittersweet tone in another early photograph, *Buffalo grazing near buffalo yards* (see supplementary photographs). By 1908, the American Bison had come under the protection of federal law, and the buffalo yards were disassembled, but the surviving individuals represented a pathetic remnant of the once vast herds.

In their remarkable portfolio of America's endangered plant and animal species, *Witness*, Susan Middleton and David Liittschwager photographed a Wood Bison (a rare subspecies of the American Bison) at Elk Island National Park in Alberta, Canada (photograph taken in 1993). Here, one sees the same shaggy bull-headedness, the same upcurving horns, even the parallel rib structure of the bison's torso -- here unskinned!

This bison is filled with life, however, and its anterior coat of dense fur, its steeply angled hump, its longer legs, and its large near-spherical body are indications of superb adaptation for life in the northern boreal forest. It is a long path from decimation to scientific and aesthetic documentation.

Our First Grizzly, killed by Gen. Custer and Col. Ludlow (1874) is a further representation of indiscriminate slaughter of North American wildlife, again at the hands of the United States Army. Custer is seen surrounded by the other members of his hunting party (a talent that did not serve him well in later life). Each member of the party has rifle in hand and is seated behind the felled Grizzly Bear. This photograph is carefully posed, with Custer framed against a field tent, a Crow Indian to his right, Colonel Ludlow to his right, and further assistance behind. The bear is propped up against a low rocky outcrop. Its splayed claws are mirrored in the elk antlers seen lying in the grass to the right. Some representations of this photograph are cropped to highlight Custer and his immediate surroundings. A more complete version of the picture shows numerous tents stretching along the far horizon, evidence of Custer's leading an enormous wagon train into the Black Hills of South Dakota. The message is clear in this photograph. The biological wealth of a young nation is available for the harvesting. Some would view this photograph as a representation of bravery, heroism, and good marksmanship. To others, it is symptomatic of the indiscriminate exploitation of a natural wonder of the living world.

Middleton and Liittschwager photographed a Grizzly Bear in 1991 at Olympic Game Farm in Washington State. This individual also is filled with life, as is particularly seen in its inquisitive eyes and the curious tilt of its head. The photographic image records a series of offset, concentric circles -- the bear's wet, dark nostril pad, its eyes, its anterior face, the full width of its head, the body that stretches away (and yet further away). Here, the paws are folded in the forward direction, suggesting that this bear has just lifted up from a contemplative dose. These claws are ready to protect, to defend, to harvest food or prepare a winter den. They convey message far different from that of Custer's trophy animal, whose forelimbs are splayed out to the side, and whose head is slumped in a death pose. Taken together, the Grizzly Bear photographs indicate America's evolving fascination with the largest predatory mammal in North America. Once widespread in its distribution throughout the West, the grizzly was decimated in numbers in proportion to the perception that as it was in direct competition with human interests. Today, the grizzly still lacks universal human good will, but it is better recognized as one of the most majestic of North American wilderness animals.

Supplementary Photographs

Buffalo Grazing Near Buffalo Yards (Wichita National Forest, Oklahoma, March 11, 1908) (National Archives No. 95-G-76223)

Natural Resource Extraction

"Photographs cannot create a moral position, but they can reinforce one -- and can help build a nascent one." (*On Photography* , page 17)

"The quality of feeling, including moral outrage, that people can muster in response to photographs of the oppressed, the exploited, the starving, and the

massacred also depends on the degree of their familiarity with these images." (*On Photography* , page 19)

Photographer J.B. Starkweather

IVA. *Gum Shan [Gold Mountain] Meets El Dorado* Quarter plate daguerreotype, (photographed c. 1852). California State Library, California History Section, Pictorial Resources, No. 912

Photographer Timothy H. O'Sullivan (1840-1882)

IVB. *Comstock Lode Mine Works, Virginia City, Nevada* (Also named *Mouth of Curtis Shaft, Savage Mine*) (Photographed January-February 1868) Albumen print, from the Clarence King Survey of the 40th Parallel (George Eastman House, Still Photograph Archive, No. 81:1887:0011)

Photographer W. Eugene Smith

IVC. *Tomoko Uemura in Her Bath* (1972)

Starkweather's photograph of American and Chinese miners is noteworthy in its use of strategies to divide the scene. The mining trough seen in the center of the image separates three miners of European descent from four miners of Eastern origin. The rail fence separates the background's farm environment of house and barn from the mining activity of the foreground. Movement is from back to front, as seen in the flow of water, the deeper upturning of the earth in the foreground, and the symbolic and literal rejection of the farm life in favor of seeking one's fortune in the quest for precious metals by placer mining. All of the miners, both Caucasian and Asian, wear a look of determination and hopefulness. All will probably meet with ultimate disappointment, failure, and destroyed health, but who knows, maybe not. They are living, in their respective ways, the nineteenth century American dream. There's a huge expanse of land out there, awaiting the eager and the industrious who might extract great wealth from the land. What appears to us today as a low technology effort was in fact a high technology endeavor that paid great dividends to those who persevered.

O'Sullivan's *Comstock Lode Mine Works* is a study in verticality and in shades of black and white. Six miners are seen at the "mouth" of the mine, three waiting in line at the left and in profile, one facing forward in the center of the image, and two that are also in frontal view to the right. Each miner is dressed in heavy protective wear -- coats, leggings, boots, and a felt hat. Each is frozen in pose, undoubtedly a reflection of the need for long photographic exposure time. The central figure is seen to emerge from behind his mining cart, head and shoulders in view. His position is suggestive both of birth and death, a mechanically assisted birth from the bowels of the Earth and delivery to a baby carriage, and death as the rigid body is consigned to its coffin. He clearly is the center of attention. At least one of the figures to the right is grasping his cart, his manual connection to Mother Earth. All six figures (the central miner, in particular) are illuminated from behind by a brilliant light (flash photography?), reflective of the intense shiny brilliance of the precious metal they are here to recover. The strong verticality of the photographic image is seen in the human figures, the

cart frames, the mining bays, and the associated fabrications of the mine entrance. All are frozen in time as they prepare for continuation of their labors. It is through their efforts that civilization is brought to the barren West and a century-old nation is brought to greater maturity.

The famous image of a mother and her stricken child in a Japanese hot tub, one of a series of photographs of the victims of Minamata Disease taken by W. Eugene Smith in 1972, is a photographic *Pieta* of the environmental movement. *Tomoko Uemura in Her Bath* shows mother and child engaged in the daily Japanese ritual of the hot bath in late afternoon or early evening. The mother, Ryoko Uemura, supports her helpless daughter Tomoko in the tub, and she directs a loving gaze at Tomoko that is intensely emotional, gentle, and filled with devotion. Tomoko's malformed limbs and torso, her locked musculature, and her fixed stare upward add poignancy to the photographic image that stays with the viewer.

The Uemura family lived and worked in one of a number of small fishing villages along Minamata Bay, on the west coast of the main Japanese island of Kyushu, to the south and west of Honshu, the largest island in the Japanese archipelago. This region of Japan has industrial plants in addition to its extensive and valuable fishing industry. In the early 1950s, a subsidiary of the Chisso Corporation produced organic chemicals including acetaldehyde and PVC plastics, and for many months it discharged its mercury-contaminated industrial waste products into Minamata Bay. In a classic example of bioaccumulation of chemical contaminants, the marine trophic food chain experienced a many thousand-fold concentration of mercury compounds, and the Minamata fishery harvested the mercury-laced top predatory fishes for its local markets. The residents of Minamata Bay began exhibiting symptoms of extreme heavy metal poisoning. Approximately three thousand people were diagnosed with Minamata disease in the ensuing months and years, nearly 3000 died as a consequence of the mercury poisoning, and perhaps two million ate the tainted fish. In many instances, including that of the Uemura family, the mercury poisoning took place *in utero*. The story of Minamata is a long and complicated one for post-World War II Japan, but it raised tremendous international attention and led to a deep awareness of the dangers posed by exposure to heavy metals such as mercury produced in industrial activities.

Global Climate Change

Photographer William O. Field

VA. *Muir Glacier* (photographed on 13 August 1941) (National Snow and Ice Data Center, Boulder, Colorado, website nsidc.org/data/glacier_photo)

Photographer Bruce F. Molnia

VB. *Muir Glacier* (photographed on 31 August 2004) (National Snow and Ice Data Center, Boulder, Colorado, Website: nsidc.org/data/glacier_photo)

The National Snow and Ice Data Center, based at the University of Colorado in Boulder, maintains an archival collection of photographs for the American Geographical Society. The photographs date from the 1880s to the present, and they document a broad range of cold climate conditions such as glaciers, ice shelves, blizzards, avalanches, and sea ice cover. The Long-Term Change Photograph Pairs Special Collection is a fine source of historical and contemporary photographs depicting evidence of climate change in the United States and

Canada. The 1941 photograph of Muir Glacier (Alaska) is a black-and-white view of glacial ice filling a U-shaped valley. The direction of flow of the glacier is evident in the alternating light and dark bands or concentric curves of ice dominating the scene. One cannot discern whether the short-term trend in this valley is one of glacial advance or glacial retreat, but the presence of ice essentially at the camera's base indicates that this glacier is well established at the vantage point chosen. The denuded left foreground indicates that at some time in the recent geological past these exposed bedrock surfaces had been scoured by the glacier. In the distance, thin slivers of mountain top emerge above the glacial ice. They are dotted with their own pockets of snow and glacial ice. This is a dynamic natural system, best evidenced by the irregular surface of the ice flow.

A 2004 view of Muir Glacier from the same vantage point gives a far different picture. The denuded landscapes of 1941 now are covered with deciduous and coniferous tree growth. The steeper mountain slopes consist of bald bedrock, while more gradual slopes, formerly covered by glacial ice, are heavily vegetated. The retreating glacier is visible in the far distance, its outer edge recessed thousands of feet from its former position. A glacial lake dominates this present day view. Its surface is located some hundreds of feet below the glacial ice surface of 1941. Scattered blocks of ice float on the lake in the foreground. The mountain peaks in the distance now appear much more massive. Their glaciers are considerably reduced in size, or the glaciers have withdrawn completely from their former cirque localities.

In recent weeks, former Vice-President Al Gore has released a film about global warming and a companion book, *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*. In the book, Gore uses paired photographs of glaciers from the United States, Patagonia, Argentina, Peru, Switzerland, and Italy, as seen in the late nineteenth century and mid-twentieth century, and seen again today. For example, Boulder Glacier in Glacier National Park (Montana) is pictured in 1932 and from the same vantage point in 1988. His collection of photographs from North America, South America, Europe, Africa, and Asia documents the substantial loss of glaciers in many parts of the world. One of the most dramatic images in *An Inconvenient Truth* is the "wastage of Columbia Glacier, Prince William Sound," Alaska evident in pictures framing the last twenty-five years. The consensus opinion that has emerged from the scientific community about the accuracy of *An Inconvenient Truth* is that Al Gore has got his facts right. His highly personal book and film are important contributions to the popular environmental literature and undoubtedly will serve as useful educational tools.

Earth From Above -- Aerial and Satellite Images

Untitled Space Shuttle photographs, NASA/Johnson Space Center

The Living Earth: A Topographical Satellite Map, (Earth Map -- Living Earth Map) color composite (NOAA satellite images). Published by SPACESHOTS Inc., Studio City, California

Photographers Reto Stockli and Alan Nelson

Earth -- The Blue Marble, composite photograph: image of Earth and clouds (photographed 9 September 1997) Geostationary Operational Environmental Satellite (GOES); ocean data collected in late September and early October 1997 by NASA's Sea-Viewing Wide Field-of-view Sensor (SeaWiFS) satellite; land color portrayed

by a vegetation index calculated using data collected from September 9 through 19, 1997 by Advanced Very High Resolution Radiometer (AVHRR) instruments onboard NOAA's Polar Orbiting Environmental Satellites (POES).

Aerial and satellite imagery have redefined our ability to view Earth's landscapes. There are numerous publications and Internet websites that provide stunning photographs of the land and water surfaces of the Earth, rich in documentary, scientific, and artistic meaning. A relative of mine, Robert Hummer of Green Valley, Arizona, played a key role in the development of the camera that took the first image of the whole Earth from space (1966). Since then, vast portions of the Earth's surface have been imaged from space, and they continue to provide important environmental monitoring of the planet.

The view of the Southern New England coastline (page 16 of *Orbit*, from Cape Cod and the Islands to Narragansett Bay and Long Island Sound) is a vivid image of a "drowned coastline," generated by Pleistocene glaciation and altered by rising sea levels. This photograph defines the location of my New Haven school and its students in a larger context than is generally perceived by many of them. The action of wind and waves is evident in the sand bar extensions of the Cape (Provincetown and Monomoy), and Long Island's Montauk and Orient Points and its barrier beaches. Numerous river valleys dissect the mainland coastline. They reflect the north-south movement of glacial ice more than 14,000 years ago. An equally dramatic view in winter (*Orbit*, page 180) shows Southern New England from Cape Cod, Nantucket, Martha's Vineyard, and Cape Ann to Narragansett Bay and Quabbin Reservoir of central Massachusetts. These and other NASA images provide a visual context for our consideration of environmental issues in our part of the country.

The Living Earth: A Topographical Satellite Map is a composite view of Earth from space, showing the world's poles, oceans, and continental land masses under cloud-free conditions. The sea floor surfaces are shaded in on the composite image, and national boundaries are superimposed on the land. This remarkable computer generated image of Earth can be used to initiate student discussion about the shapes of the continents, the profound differences in land cover of Northern and Southern Hemispheres, the distribution of such ecosystems as the tropical, temperate, desert, polar, and marine, and the consequent global connectedness of our current environmental problems. *Earth -- The Blue Marble* is yet another computer generated view of our planet that has used computer enhancement to exaggerate the elements of vertical relief on Earth's surface. Mountain ranges stand out in artificial grandeur as North America and South America appear to spin below the space-based vantage point. The dull shades of gray and white of the lifeless Moon are seen beyond the living "blue marble" Earth. Swirling storm clouds hover above the Pacific and North Atlantic Oceans, and Earth's land surfaces provide rich greens and browns in a surrounding sea of deep blue. Whether factual depictions of Planet Earth or computer generated representations of the planet that twist space and defy time and ever-present weather conditions, these space images are invaluable for the teaching of environmental science.

Supplementary Photographs

Photographer Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC

VIA. *Snow Across New England and Quebec*. (Image from 15 November 2004) Sensor: Terra/MODIS; Website: veimages.gsfc.nasa.gov/6749/NortheastUS.A2004319.1600.1km.jpg

Photography by MODIS Land Rapid Response Team/NASA

New England 11/14/04 (2004)

Website: modis-snow-ice.gsfc.nasa.gov/111404pa.html

Photographer Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC

Aqua MODIS true color image of the Eastern United States, 22 March 2004 ,

(Image from 24 March 2004)

Website: modis-snow-ice.gsfc.nasa.gov/032204eus.html

Photography by NASA/GSFC/JPL, MISR Team

MISR Looks at Cape Cod. (Image from 22 November 2000)

Website: veimages.gsfc.nasa.gov/1501/PIA02633.tif

Photography by SPACESHOTS, INC (Studio City, California)

Cape Cod: A Satellite View , satellite image Website: www.spaceshots.com

Classroom Activities and Sample Lesson Plans

My analysis above provides suggestions for how historical and contemporary photographs may be used to teach concepts and principles in the environmental sciences. As a result, the sample lesson plans shown here provide little more than an outline of the different types of classroom activities that I use in this curriculum unit.

I. The Reading of Photographs

"Photographs furnish instant history, instant sociology, instant participation." (*On Photography* , page 75)

As an initial lesson in the use of photographs to teach topics in environmental science, I project digital versions of the historical and contemporary photographic images on a large screen constructed in the classroom for this purpose. I encourage my students to "read" the photographs in a systematic way (see above). We are concerned with the subject matter of the images, the multiple meanings that are carried by the photographs, our perceptions of the photographer's intent in making each image, the scientific content that can be extracted from close examination of the images, and the artistic merits of the photographs. I identify each photograph with a brief statement about its subject matter. My students then begin an analysis of the photograph as they study its various details. The range and directions taken by student comments are not expected to be predictable in any way, although future use of the same images will enable me in time to construct a body of information that emerges from the perceptions of many students. Each image may require ten or more minutes of projection, particularly the first ones shown. Photographs that add to the environmental "story" that I endeavor to tell can be projected for equivalent or for shorter periods of time. In this fashion, my students and I will seek an understanding of the various dimensions and meanings of the photographs and how they communicate information about the natural and human-altered environments.

II. Writing From Photographs

In this classroom activity, my students are asked to compose an essay of at least four pages that addresses the environmental and artistic significance of one of the photographs studied in class. Our school district has placed increased emphasis on reading for information in all subject areas, with district-wide reading assignments being provided to all ninth and tenth grade students. I complement these reading for information assignments with "reading photographs for information" assignments. I feel that these assignments will generate similarly valuable skills in my students, such as enhancing their powers of observation, their assimilation and interpretation of content, and their ability to deduce and speculate about the intentions of the makers of the photographs. In fact, they will make deductions and speculate in ways that could not have been anticipated by the photographers. The written assignments will follow a pattern similar to that of classroom discussions, with students expected to address the environmental (scientific) content of the photograph, its "style" and artistic merits, the point of view of the photographer, the multiple meanings that can be found.

III. Matching Photographs with Quotes From the American Environmental Literature

". . . an increasingly common way of presenting photographs in book form is to match photographs themselves with quotes." (*On Photography* , page 71)

My students are assigned medium-length readings from each of the key figures of the American environmental movement (see the Annotated Student Reading List). They include Thoreau's *Walden Pond* and *Cape Cod* , Marsh's *Man and Nature* , Leopold's *A Sand County Almanac and Sketches Here and There* , Carson's *The Sea Around Us* , and *Silent Spring* , and Wilson's *Naturalist* and *The Future of Life* . The task of each student, working individually or in a small group, is to match each of a series of photographs of environmental content with an appropriate quotation from the writings assigned. As Susan Sontag states, a number of well-known books have been reissued with accompanying photographs that support or reinforce the narrative views and beliefs of the authors. For example, I have copies of illustrated versions of Thoreau's *Walden* and Carson's *The Sea Around Us*. The task of my students is to provide some written explanation of their pairings of photographs and the author's quotations. I suspect that this assignment will encourage extensive research and original thinking on the part of my students. It also will lead to the identification of a collection of photographs that will be new to me and that will enhance the teaching of environmental science.

Annotated Teacher Bibliography

Cronon, William. 1983. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. New York: Hill & Wang, 241pp. (Cronon's important ecological history is based on the use of narratives of early travelers and naturalists, deeds, surveyors' records, town and court records, archaeological evidence, and modern ecological study of forest stands, tree rings, charcoal deposits, and fossil pollen profiles.)

Knight, Richard L., and Suzanne Riedel, eds. 2002. *Aldo Leopold and the Ecological Conscience*. New York: Oxford University Press, 190pp. (The introductory chapter by Knight and Riedel states that this "collection of essays by ecologists, wildlife biologists, and conservationists documents the legacy of Aldo Leopold and *A Sand County Almanac* to the environmental movement, ecological sciences, and natural resource management.")

Lowenthal, David. 2000. *George Perkins Marsh: Prophet of Conservation* . Seattle: University of Washington Press, 605pp. (Chapter 13 Man and Nature: *The Making* and Chapter 14 Man and Nature: *The Meaning* are useful to this unit. Lowenthal writes, "[a]fter a period of relative neglect, *Man and Nature* was resurrected by Americans made newly aware of the perils of floods and soil erosion by Dust Bowl and other disasters of the 1930s.")

Middleton, Susan, and David Liittschwager. 1994. *Witness: Endangered Species of North America* . San Francisco: Chronicle Books, 255pp. (The book jacket states of these photographic portraits of endangered species, "[e]ach page reveals the astounding diversity that is still present in our world, and each portrait inspires action to protect these fragile lives that hover above extinction.")

Nash, Roderick, 1982. *Wilderness and the American Mind* (third edition). New Haven, Connecticut: Yale University Press, 425pp. (Nash writes of Thoreau and wilderness, Marsh and man's alteration of nature, Muir and Hetch Hetchy, Leopold and the ecological conscience and the land ethic, and 'the argument to keep the options of the future open with regard to something [- wilderness -] that, by definition, mankind can never create.")

Orvell, Miles. 2003. *American Photography* . New York: Oxford University Press, 256pp. (Used by seminar leader Alex Nemerov for assigned readings, this current history of American photography includes Chapter 3 Viewing the Landscape.)

Sontag, Susan. 1977. *On Photography* . New York: Farrar, Straus and Giroux/Picador, 208pp. (Sontag's challenging essays on the multiple meanings and values of photographs have abundant reference to the various ways of representing the natural world.)

Turner, Raymond M., et al. 2003. *The Changing Mile Revisited: An Ecological Study of Vegetation Change with Time in the Lower Mile of an Arid and Semiarid Region* . Tucson: The University of Arizona Press, 334pp. (This photographic study of the oak woodlands, grasslands, and desert lands of the Sonora Desert (Arizona) uses fixed camera stations to depict one hundred years of ecological change -- from the 1890s to the 1990s -- resulting from changing climate conditions and from human disturbance.)

Walls, Laura Dassow. 1995. *Seeing New Worlds: Henry David Thoreau and Nineteenth-Century Natural Science* . Madison: The University of Wisconsin Press, 300pp. (The author's "rereading of Thoreau's career" enables her to recognize that "Thoreau participated in and helped to advance an alternative tradition of romantic science and literature that looked toward ecological approaches to nature . . .")

Worster, Donald. 1994. *Nature's Economy: a History of Ecological Ideas* (second edition). New York: Cambridge University Press, 507pp. (From Gilbert White and the Age of Reason to Edward O. Wilson and the Age of Ecology, Worster's "history of ecological ideas" is the most comprehensive treatment available on the history of ecological science.)

Annotated Student Reading List

Apt, Jay, Michael Herlfert, and Justin Wilkinson. 1996. *Orbit: NASA Astronauts Photograph the Earth* . Washington, D.C.: National Geographic Society, 224pp. (This is a rich source of photographs from space, organized by continent and emphasizing land formations, geologic processes, weather systems, and human alteration of the globe.)

Carson, Rachel. 1998. *Lost Woods: The Discovered Writing of Rachel Carson* . Boston: Beacon Press, 267pp. (This collection of "youthful writing, newspaper essays, field journals, speeches, articles, and letters" of Rachel Carson includes her powerful January 1963 address to the Garden Club of America, entitled "A New Chapter to Silent Spring.")

Carson, Rachel. 1962, 2002. *Silent Spring* (40th anniversary edition). Boston: Houghton Mifflin Company, 378pp. (In his history of the

global environmental movement, McCormick writes, "The single event most frequently credited as signifying the beginning of the environmental revolution was the publication in 1962 of *Silent Spring* by Rachel Carson.")

Carson, Rachel. 1950, 2003. *The Sea Around Us* (an illustrated commemorative edition). New York: Oxford University Press, 274pp. (This recent edition well exemplifies Susan Sontag's "increasingly common way of presenting photographs in book form" by associating photographs with written narrative and "quotes.")

Gore, Al. 2006. *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*. Emmaus, PA and New York: Rodale Books/Melcher Media, 328pp. (The book and the film have generated considerable interest in the general public and the scientific community.)

Marsh, George Perkins. 1864, 2003. *Man and Nature*. Seattle: University of Washington Press, 472pp. (Marsh's ground-breaking book on a broad range of ecological issues is remarkably current in its subject matter. A forward by Bill Cronon and an introduction by David Lowenthal set the context for reading *Man and Nature* one hundred sixty years after its original publication.)

Miller, G. Tyler, Jr. 2002. *Living in the Environment: Principles, Connections, and Solutions* (twelfth edition). Belmont, California: Brooks/Cole -- Thomson Learning, 758pp+appendices. (This is the text I use for the AP Environmental Science course I teach. New editions appear in alternate years.)

Raven, Peter H., and Linda R. Berg. 2001. *Environment* (third edition). Fort Worth, Texas: Harcourt College Publishers, 612pp+appendices. (Chapter 3 Addressing Environmental Problems, Part II includes an excellent overview of the environmental movement in the United States, with reference to key historical figures, a case study on "Old-Growth Forests of the Pacific Northwest," and an articulation of environmental ethics and environmental worldviews. Historical (pre-flooding) and contemporary photographs of Hetch Hetchy Valley in Yosemite exemplify the approach to environmental education that is the basis of this unit.)

Wilson, Edward O. 2002. *The Future of Life*. New York: Alfred A. Knopf, 229pp. (Edward O. Wilson is our leading scientist in the study of biological diversity and our most gifted naturalist-writer. From his prologue letter to Thoreau to his proposed solution to the long-term prospect of biological impoverishment on Earth, he makes a rational and impassioned case for the "preservation of the living world" in terms of "our material prosperity and health" as well as the "defining qualities and self-image of the human species.")

Wilson, Edward O. 1994. *Naturalist*. Washington, D.C.: Island Press/Shearwater Books, 380pp. (This is a fascinating biographical account of Wilson's development as the world's spokesperson for the protection of biological diversity and environmental common sense.)

Classroom Materials

A Photographic Collection of Environmental Subject Matter (in digital format and, where possible, printed form)

A Collection of Photographs of Key Figures in the American Environmental Movement, including:

Henry David Thoreau: 3a02153r.jpg> images-1_1.jpg>

George Perkins Marsh: photo-gpmarsh3.gif> 06781r.jpg>

John Muir: images-27.jpg>

John Muir and Theodore Roosevelt: images-14.jpg>

Theodore Roosevelt: 3c16511v.jpg> "The Nation's Chief before the Forest King - President Roosevelt in Big Tree Grove, Santa Cruz, California" (stereograph view)

Aldo Leopold: images-4.jpg>

Rachel Carson: images.jpg>

Edward O. Wilson: images-8.jpg>

Map of Yosemite Valley, Yosemite National Park, California, Mariposa County. United States Department of the Interior, Geological Survey, 1958. (Scale 1:24,000)

Appendix

This curriculum unit is intended for use in the Advanced Placement Environmental Science (APES) course that I have taught at Wilbur Cross High School for the past six years. As stated in the College Board/Advanced Placement Program Course Description (Acorn Book),

"the goal of the AP Environmental Science course is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving and/or preventing them."

This is a full year course that leads to the taking of a national Advanced Placement examination in May. The College Board/Advanced Placement Program provides an outline of the AP Environmental Science course. The AP Program and the school districts around the country that use this curriculum have high expectations for successful mastery of subject matter by students taking the APES course. It is thus highly desirable that any elaboration of the curriculum be mindful of the preparation of students for the national test. I have developed this curriculum unit to present topics in environmental science with which students need be familiar for the multiple choice and the free response sections of the APES exam. It is my view that an historical approach to these topics that makes use of photographic images is an effective way to teach the subject matter.

Contemporary physical sciences and life sciences are best understood through awareness of their historical development. Science employs specific methods of observation and description, experimentation, and theorizing in order to reveal to us the workings of the natural world. Science at its best is a self-correcting process of discovery. An understanding of modern science requires mastery of some basic principles and concepts in physics, chemistry, and geology (the physical sciences), and the various divisions of the life sciences (among them systematic biology, ecology, population biology, and evolutionary biology). The pace of discovery in the physical and life sciences today is more than a little daunting, yet our ability to address the many societal issues having an underlying scientific basis requires that we be well educated about principles, concepts, and applications of scientific knowledge.

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