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LIFE AS A SOBER CITIZEN: ALDO LEOPOLD'S WILDLIFE ECOLOGY 118

By

Nancy Stearns Theiss
B.A., University of Louisville, 1974
M.A., Murray State University, 1978

A Dissertation
Submitted to the Faculty of the
Graduate School of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Doctor of Philosophy

Department of Teaching and Learning
University of Louisville
Louisville, Kentucky

August 2009

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A Dissertation Approved on

June 8, 2009

by the following Dissertation Committee:

Dissertation Director

DEDICATION

This study is dedicated to the Aldo Leopold Foundation whose mission is to foster the land ethic through the legacy of Aldo Leopold.

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I would like to acknowledge the following folks who helped me with this study:

To my parents: who provided me sustenance on a farm as a child, with few restrictions and lots of tolerance for my garden activities and the mice, turtles, ducks, and spiders, who often found their way into the bathtub or my bedroom.

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ABSTRACT

LIFE AS A SOBER CITIZEN: ALDO LEOPOLD'S WILDLIFE ECOLOGY 118

Nancy Stearns Theiss

August 11, 2009

This historic case study addressed the issue of the lack of citizen action toward environmentally responsible behavior. Although there have been studies regarding components of environmental responsible behavior [ERB], there has been little focus on historic models of exemplary figures of ERB. This study examined one of the first conservation courses in the United States, Wildlife Ecology 118, taught by Aldo Leopold (1887-1948) for 13 years at the University of Wisconsin. Today, Aldo Leopold is recognized as an exemplary conservationist whose land ethic is cited as providing the ecological approach needed for understanding the complex issues of modern society.

The researcher conjectured that examination of one of the first environmental education courses could support and strengthen environmental education practices by providing a heuristic perspective. The researcher used two different strategies for analysis of the case. For Research Question One—"What were Leopold's teaching strategies in Wildlife Ecology 118?"—the researcher used methods of comparative historical analysis. The researcher examined the learning outcomes that Leopold used in Wildlife Ecology 118 and compared them against a rubric of the Four Strands for Environmental Education (North American Association for Environmental Education [NAAEE], 1999). The Four Strands for Environmental Education are the current

teaching strategies used by educators. The results indicated that Wildlife Ecology 118 scored high in Knowledge of Processes and Systems and Environmental Problem Solving strands. Leopold relied on historic case examples and animal biographies to build stories that engaged students. Field trips gave students practical experience for environmental knowledge with special emphasis on phenology.

For Research Question Two—“What was the context of the lessons in Wildlife Ecology 118?”—the researcher used environmental history methods for analysis. Context provided the knowledge and understanding of Leopold’s choices for developing lessons that he thought would engage students to become environmentally responsible citizens. The contexts were grouped into four categories: (a) work and research related, (b) professional development, (c) leisure and, (d) public service. There were five themes that emerged from the course contexts: (a) case histories, (b) animal biographies, (c) phenology application, (d) food chains, and (e) ecosystems.

The results of the study indicated that Wildlife Ecology 118 ranks high in areas of environmental problem solving and knowledge of processes and systems. Both of the areas are often difficult for educators to incorporate in their lessons. Through case histories, animal biographies, phenology, ecological diagrams, ecosystem comparisons and field trips, Leopold provides many examples that can be easily updated and used in current classroom practices, both in K-12 and college levels.

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CHAPTER ONE

INTRODUCTION

The mouse is a sober citizen who knows that grass grows in order that mice may store it as underground haystacks, and that snow falls in order that mice may build subways from stack to stack: supply, demand, and transport all neatly organized. To the mouse, snow means freedom from want and fear. *A Sand County Almanac, Aldo Leopold*

Environmental Literacy for Global Citizenship

By the time a baby born today, in the United States, reaches age 75 he or she will have produced 52 tons of garbage, consumed 43 million gallons of water, and used 3,375 barrels of oil (Geohive, 2005, United Nations [UN], 2007). For packaging alone, the United States uses approximately 50% of its paper, 75% of its glass, 40% of its aluminum and 30% of its plastics. Each year in the United States, 180 gallons of motor oil, the equivalent of 16 Exxon Valdez oil spills, is sent to landfills or poured down drains. Other statistics about the United States' consumptive patterns show that one fifth of the groundwater supply used is nonrenewable. Americans blacktop 1.3 million acres of land annually and lose over one million acres of cropland to erosion (Geohive, 2005). The misuse of nonrenewable and renewable resources is producing "short-term economic gain for few and long-term environmental destruction and disease for many" and is "undemocratic, unsustainable, and stupid" (Reece, 2005, p. 60).

The over consumption of resources by citizenries in industrialized countries such as the United States demonstrates values where "technology and wealth" mean more than "community" and "citizenship" (Reece, 2005, p. 60). Consumerism has increased in areas

among the highest-income countries, accounting for 86% of the total private consumption expenditures worldwide (Mayell, 2004). Consumers in industrialized nations are characterized by diets of highly processed foods, bigger houses, more and larger cars, and high levels of debt, in essence, lifestyles that accumulate non-essential goods. The richest top fifth of nations consume 45% of all meat and fish, 58% of total energy, and 84% of all paper and own 87% of the world's vehicle fleet (Shah, 2004, pp. 1-6).

When people consume resources, there is always some loss of energy. Renewable resources conserve energy because they recycle and replenish the supply to some degree, even though there is some loss of energy that cannot be regenerated. Non-renewable resources, such as fossil fuels, are derived from deposits of organic materials that have decayed over time. These are much more difficult to recycle because, when used, most of their energy is dissipated as heat into the environment. One must also take into account the large-scale waste that is produced when mining fossil fuels. Lifeless landscapes are being created by the massive mining practices that create havoc—removing mountaintops and producing mudslides, floods, slurry, and oil spills, not to mention the long-term pollution of water resources (Reece, 2005).

These wastelands created by human actions and global warming from human activities are the most urgent concern (Hansen, 2007; Kamenetz, 2008; Trenberth, 2001; UN, 2007). Climate models show the earth is “out-of-balance,” with more energy absorbed from the sun than emitted to space (Hansen, 2007). This growing planetary imbalance has no precedence and is due to human activity, primarily the emissions of CO₂ and CH₄ and thermal inertia of the oceans. It is predicted that 37% of the world's species

may become extinct due to the increasing effects of global warming caused by carbon dioxide emissions (Mayell, 2004).

Carbon dioxide emissions result from the use of fossil fuels, like the burning of gasoline from sources such as cars, and from the production of electricity. Scientists warn that the window of opportunity to slow the current trends is narrowing down to the next 10 years (Hansen, 2007). Scientists who study arctic regions note that these areas are warming at twice the rate of the rest of the world. “As permafrost melts, for instance, it could unlock vast stores of carbon from rotting ancient organic plants and animals, fueling even more warming” (Bruggers, 2006, p. A11). Locally, changes may seem more subtle, but the effects of global warming are impacting plants and animals by altering animal migration and plant growth. Animals are migrating earlier and wildflowers are blooming sooner (Bruggers, 2006).

Concerns from the local to global level caused nations to create an international effort to reduce carbon emissions. The Kyoto Treaty was drawn up in Kyoto, Japan, in 1997 to implement the United Nations Framework Convention for Climate Change. It legally binds industrialized nations to reduce worldwide emissions of greenhouse gases by an average of 5.2% below their 1990 levels over the next decade (UN, 1992, p.1). Unfortunately, support for this global partnership did not include the United States, which is responsible for 20.5% of the world’s carbon dioxide emissions (UN, 2007). The United States pulled out of the agreement in March 2001, and President Bush stated that the US would never sign it because the restrictions “are flawed and could hurt its economy” (Coleman, 2005, p. 2). A delay by the United States in the participation of the Kyoto

Protocol has resulted in an estimated increase of 2 percent per year in global CO₂ emissions (Hansen, 2007).

Wasting natural resources denies those resources to people who have less, according to the United Nations (1998). A person in the United States causes 100 times more damage to the global environment than a person in a poor country. “Of all the CO₂ emissions produced from fossil fuels” the United States is “responsible for 30 percent, an amount much larger than that of the next-closest countries, China and Russia, each producing less than 8 percent” (Hansen, 2007, p. 7).

Since 1940, Americans have used up as large a share of the Earth’s mineral resources as all previous generations put together (New Road Map Foundation, 2004). This massive consumptive pattern, particularly by industrialized nations, undermines the environmental resource base exacerbating inequalities among nations. The poorest of the world’s people have been left out of the consumptive patterns to the point of stagnation. Well more than 1 billion people worldwide lack sanitation, proper nutrition, modern health services, and housing (UN, 2007).

The Bush Administration argues that it is being environmentally responsible (Coleman, 2005), but after the adjournment of the 108th Congress in November 2004, the League of Conservation Voters (2004) reported that the House of Representatives approved a “smorgasbord” of anti-environmental legislation. The legislation was only stopped in the Senate because of the overwhelming cries of outrage by citizens and environmental groups. Many believe the Bush Administration has “misplaced priorities,” doing little to curb the energy appetite of consumers that is “hastening the climate change crisis” (Friedman, 2005).

For some, environmental legislation is seen as negative for the economy because it does not support competitive markets that create capital gains. Proponents of market capitalism believe that to stimulate economies, consumers need to be encouraged to buy items and to be aggressively marketed through competitive advertising (UN, 2007). Yet the thoughtless indifference to environmental consequences from the current gluttony of resources demonstrates total disregard for other humans and other life on earth.

Most Americans agree that human life is nourished and sustained by consumption. The real issue is not consumption itself but rather the patterns and effects of individual consumptive behavior. Americans comprise 10% of the world's population yet consume 25% of the world's resources (Geohive, 2005). The continued waste of resources rejects the country's responsibility to the rest of the world. If trends in world growth continue, China and India will surpass America's consumptive patterns in the next few decades (Sachs, 2005). Now is the time for Americans to demonstrate global environmentally responsible behavior and extend the notion of a democratic society that respects the rights of all citizens.

Citizenship requires a global consciousness to consider the ripple effect of individual actions on other people within a nation and across the globe. This global consciousness is magnified through the Internet, where people can amass forces beyond imagination. On the other hand, the Internet can be used to exacerbate the potential for accelerated resource abuse. The Internet adds to the expansion of military and financial data in a more expedient manner and fuels the potential of drastic human actions on a more global level (Arike, 2006). High-speed communication systems, global warming, and the increasing technological interventions to control various aspects of the environment, such

as weather (Arike, 2006) and energy (Mayell, 2004) imply a bleak future for all life on Earth.

To reverse the trend of the impending environmental crisis, citizen support is needed on a massive scale to support environmental programs. The National Environmental Education Training Foundation [NEETF]/Roper research reveals that 95% of American adults think that environmental education should be taught in schools and that 90% believe that generally all people in adult society should receive environmental education (Coyle 2004, p. 4). Over the last three decades, the professional field of environmental education has become popular: An estimated 30 million K-12 students and 1.5 million teachers participate in environmental instruction annually (p.12).

Increased programming in environmental instruction, however, has not improved responsible behavior toward the environment. The Summary of Environmental Readiness for the 21st Century indicates Americans are not prepared to handle complex environmental issues (NEETF, 1999). Surveys conducted from 1997-2001 by NEETF/Roper assessed whether members of the public could “readily point to the most significant environmental principles and related problems and indicate a rough understanding of their causes” (Coyle, 2004, p. 13). Survey results showed low levels of understanding on four issues: (a) basic environmental facts, (b) causes of problems, (c) science and, (d) lack of understanding about environmental issues (Coyle, 2004, p. 14).

A more recent poll (Standford University Poll, 2006) confirmed the findings by NEETF. When asked about global warming, respondents indicated they believed the Earth was getting warmer, but were divided on whether humans were the cause. The poll also indicated that most saw global warming as a cause for future generations and wanted the

government to do more, but they did not want to pay increased taxes to reduce energy consumption. During an age in which there are clear indications of pending environmental crisis, individuals still have not embraced the many environmental issues in their community over which they can have control (NEETF, 1999).

Environmental education programs have tried to address issues that emphasize local problem solving. Environmental education is defined by Kentucky legislation (KRS 157.900 to 157.915) as “an education process dealing with the interrelationships among the natural world and its manmade surroundings; is experienced based; is interdisciplinary in its approach; and is a continuous, lifelong process that provides the citizenry with the basic knowledge and skills necessary to individually and collectively encourage positive actions for achieving and maintaining a sustainable balance between man and the environment” (Kentucky Environment Education Council [KEEC], 1999).

Positive action using authentic experiences are the best examples that educators can provide to stimulate their students’ purpose for expanding their own potentials, guiding them to act as responsible stewards of the future. Nature’s diversity provides a multifaceted and experiential guide because it is changing and unpredictable and it stimulates and awakens many of our senses that have been dulled by homogenous environments. The North American Association for Environmental Education [NAAEE] (1999) suggests that teaching environmental education methods should include four strands: (a) question and analysis, (b) knowledge about processes and systems, (c) environmental problem solving and, (d) personal and civic responsibility (1999).

Currently, models of successful environmental education programs are being developed that address issues revealed from the NEETF/Roper study (NEETF, 1999) and

include the four strands for teaching environmental education (NAAEE, 1999). In a nationwide study, examples are given of successful educational practices that have increased academic achievements while increasing environmental stewardship (Coyle, 2004). “Investigating and Evaluating Environmental Issues and Actions” [IEEIA], showed improved critical thinking and problem-solving skills for identifying actions to resolve environmental issues (Coyle, 2004, p. 59).

The magnitude of global environmental disaster (Stanford University Poll, 2006) indicates that major efforts are needed by citizens the world over to reverse current trends. As human consumption patterns continue to strain natural resources, good citizenship requires a broad-minded approach that embraces an understanding of today’s impending environmental crisis (Ecofuture, 2004; Trenberth, 2001). Research over the past 100 years has wedded humanity to a world of nature, both genetically and culturally. This broad-minded approach is often referred to as *systems thinking* or ecological literacy that includes an interdisciplinary approach to understanding. To that extent, we must “find the courage to look squarely at our common situation as human beings” and embrace an “attitude of appreciation, acceptance, and compassion” as the only tenable solutions for the global ecological crisis (Searles, 1960, pp. 137-138). Understanding the current ecological crisis can be achieved only through the combination of natural and social sciences underscored by historic perspectives.

Problem Statement

A democracy relies on its citizens to uphold the aspects of democratic principles that protect the rights of individuals and the conservation of our land (Berry, 1987; Leopold, 1970; Titus, 1994). The lack of citizen response to the current environmental

crisis indicates a need for a broad interdisciplinary educational initiative that encourages proactive behavior. (ICCE, 1997; NEETF, 1999; Stanford University Poll, 2006).

Purpose

The purpose of this study was to amplify the suc conservation practices from an exemplary environmentalist, Aldo Leopold (1887-1948), in galvanizing citizen action for environmental responsibility. Aldo Leopold's land ethic has been cited as a watershed in providing the ecological approach needed for understanding the complex issues of modern society. Leopold was the first to place humans within the ecological community rather than outside of it. "In short, a land ethic changes the role of *Homo sapiens* from conqueror of the land community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such" (Leopold, 1970, p. 240). Historical analysis is used for this study to examine Leopold's teaching practices that connected citizens to their ecological community.

Study Rationale

A historic analysis can illuminate the dynamic tensions between people and their environments that took place during the rise of an industrial age in the early 20th Century. "An overview of the role of science in making possible the technologies that were the basis of the Industrial Revolution would provide students a more complex understanding of the cultural influences on the changes they study in their environmental education class" (Bowers, 2001, pp. 145-146). The researcher hopes to defragment people's knowledge by providing a heuristic paradigm, based on culture and technology, of how people's behavior toward the natural world has changed over time, (Feld & Basso, 1996; Thomashow, 1995).

This study concentrates on teaching strategies Aldo Leopold used with his students at the University of Wisconsin between 1939-1948 in a course developed, Wildlife Ecology 118, to increase their knowledge and responsibility to the environment. There have been studies regarding components of environmentally responsible behavior [ERB] (Sia, Hungerford, Tomera, 1986), but little focus on historic models of exemplary figures of ERB that could help substantiate current ERB research (Smith-Sebastio, 1995; Vaske, 2001). Leopold's legacy (Newton, 2006) extends citizens environmental responsibility on a global level. Although many studies have explored Leopold's legacy as a wildlife ecologist, naturalist, and philosopher, few have delved into his teaching praxis during his tenure at the University of Wisconsin.

The Progressive Era marked the beginning of regulations on the use of natural resources on a national scale. Environmental problems and issues were beginning to develop from the rise of industrialism and rapid technological expansion. It was a time when President Teddy Roosevelt (1913/1985) "called for citizens to come together for the common good of the nation" (p. 185) so that the dwindling supply of natural resources could be managed for the benefit of everyone. The United States began to stretch its muscle as an emerging superpower. Issues today can be clarified by an analysis of environmental education during this period of expansion. Research that uses historic models for environmental problem-solving deepens critical thinking and provides the tools for present and future environmental issues. While the Progressive Era relished human achievements that distanced people from their natural environments, the new science of evolution confirmed the undeniable connections of humans to the ecology of non-human organisms.

Questions for Study

Leopold formulated his land ethic during his years at the University of Wisconsin and developed a course, Wildlife Ecology 118, as one of the first environmental education courses in the United States. The course was designed to help students become more aware of the ecological connections between people with their environments. Leopold felt these connections would help people become better citizens of their communities. To clarify how Leopold developed and taught Wildlife Ecology 118, the researcher looked for data that would reveal content and context of the course. Content consisted of the course lessons, assessments and field trips that made up Wildlife Ecology 118. Context provided the underpinning themes and circumstances of the content. The central research questions are:

1. What were Leopold's learning outcomes in Wildlife Ecology 118?
2. What was the context of the lessons in Wildlife Ecology 118?

Definition of Key Terms

The terms defined below clarify reader understanding of this study:

1. Conservation education—term used during Leopold's time period that referred to the conservation of natural resources and whose goal was to prevent the extinction or decline of a species (Clepper, 1996). For this study, conservation education and environmental education mean the same thing
2. Community— an interacting population of various species in a common location (Odum, 1971).

3. Culture—the beliefs and mores that people have to interact with others. People’s beliefs and mores are formed through cultural transmission. Cultural transmission is acquired by individuals through “the imitation of others or by teaching” (Boyd & Richardson, 1985, p. 283). Cultural acquisition begins at birth and is acquired in sequence by directly copying the phenotype of others. This behavior is copied vertically from parents and siblings, horizontally from peers and obliquely from others such as mentors and teachers.
4. Ecology—the study of interrelationships that link together members of an ecological community and emphasizes the context of things with their environments. An ecological view (Crabtree, 2000) regards a living system as a network that organizes form and pattern with an emphasis on process rather than structure.
5. Environmental Education— a process dealing with the interrelationships among the natural world and its manmade surroundings; is experienced based; is interdisciplinary in its approach; and is a continuous, lifelong practice that provides the citizenry with the basic knowledge and skills necessary to individually and collectively encourage positive actions for achieving and maintaining a sustainable balance between man and the environment. Research indicates that environmental education programs should include four strands: (a) questioning and analysis skills, (b) knowledge of environmental processes and systems, (c) skills for understanding and addressing environmental issues, and (d) decision-making and citizenship

skills (NAEE, 1999).

6. Environmental literacy— “the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore or improve the health of these systems” (Disinger & Roth, 1992).
7. Leopold’s Land Ethic— credited with changing views about human relationships with the land. Leopold’s land ethic placed the human relationship inside the network of ecosystems, making the issue of sustainability prominent. Leopold stated, “A land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it” (Leopold, 1970, p. 240). For this study, Leopold’s land ethic and environmental literacy mean the same thing.
8. Phenology—the science that relates climate to periodic events in plant and animal life (Critchfield, 1966). Phenological data may include such facts as dates of germination, emergence of seeds, budding, flowering, ripening, migrations of animals, mating season activities, birth events, etc. These events depend on the environmental conditions that precede each event as well as on the climate factors at the time of occurrence of the event. Their specific relationship to climatic events is not fully understood by they nevertheless represent observed facts of plant and animal activity that can be put to practical use.

Summary of Chapter

As a leader in world politics and as a democratic nation that consumes 25% of the

world's resources, the United States must support educational initiatives that support environmentally responsible behavior. Principles of democracy include foremost, a society that respects the rights of all citizens. Citizenship in a democracy today requires a global consciousness to consider the ripple effect of individual actions on other people within their nation and across the globe.

Good models of study include historical perspectives that can be used as comparisons for best practices of educational initiatives. The purpose of this study was to amplify the successful conservation practices from an exemplary environmentalist, Aldo Leopold (1887-1948), in galvanizing citizen action for environmental responsibility. Leopold developed the first college course, Wildlife Ecology 118, in environmental education. A study of Wildlife Ecology 118 can be compared to today's models in environmental education to amplify best practices for educators to implement with students. The following chapter provided historical context of Leopold's life and the environmental crisis in the United States. The last section of the chapter gives current suggested practices in the field of environmental education that can be compared to Leopold's Wildlife Ecology 118 course.

CHAPTER II

LITERATURE REVIEW

Aldo Leopold developed Wildlife Ecology 118 in 1939, when the environmental conflicts among government, business, and citizens had begun to reach national proportions. Many of these specific events are linked to conditions that persist today in environmental decision-making. This chapter is divided into three sections to illustrate the interaction of the various forces of continuity and change over time, as well as to provide an update of environmental education standards today that could be used for analysis of Wildlife Ecology 118.

The first section examines the historical context and highlights the dominant environmental issues during Leopold's career. There are four subsections that delve into these various aspects of environmental issues that influenced Leopold's views and actions: (a) the emerging tensions of private versus public management of the nation's natural resources; (b) Leopold's early career in forest management; (c) Leopold's tenure at the University of Wisconsin; and (d) the new science of ecology.

The second section gives historical context to the environmental crisis in the United States and examines current lifestyles that stymie effective problem-solving at the local level. In a world of mass communication, consumerism, and mobility, the dependence on science and technology has broken bonds of trust and reliance within

communities; as a result, people are less connected on the local level (Postman, 1985; Turkle, 2009).

In the third section, the researcher developed a rubric (Area Education Agency 267 [AEA 267], n.d. ¶) from the Four Strands for Environmental Education for teachers to follow that implements the suggested concepts for environmental education. The researcher developed these rubrics for college level courses however they have application in K-12 levels. The four strands were introduced in Chapter One as the methods for developing a citizenry that demonstrates environmentally responsible behavior (NAAEE, 1999). The strands are used for comparison to Leopold's strategies for environmental education.

Key Environmental Issues during Leopold's Career

Leopold's lifetime (1887-1948) encompassed a pinnacle in human history when an avalanche of scientific discoveries touched every citizen. Management issues of land and resources redirected government's influence on a broad scale and reached international proportions. The following discussion explores the issues of management on a large scale and the conflicts of government regulation and private ownership.

Tensions of Private Versus Public Resource Management

The Progressive Era was an attempt to begin a process of healing from three centuries of "chronic environmental exploitation" (Worster, 1988, p. 175). The economic enterprise of the United States underwent a great shift in natural resource use. The early 20th century was a critical period in American history. Masses of wildlife and forest reserves had been depleted by uncontrolled human gluttony. The bison herds and other abundant game, passenger pigeons, fisheries, and virgin forests had succumbed to massive

settlements, agricultural practices, and “demography, technology, and energy” (Worster, 1993, p. 6).

The rise of mass production and mass consumption distanced people from the land. People were no longer directly dependent on the resources within their backyards. Their fuel, transportation, food, clothing, and energy came from other places, and the physical toil and efforts of acquiring goods and supporting daily needs were replaced with more leisurely activities. At the end of the 19th century, the depletion of resources testified to this change. By 1890, the Census Bureau determined that the “frontier was closed” (Worster, 1988, p. 233).

The concern for the loss of these resources of the western frontier was a top priority for U.S. President Teddy Roosevelt, who was known for his love of wilderness and sense of conservation (Roosevelt, 1985). Under Roosevelt’s Progressive Era, politics entered into the arena of the conservation movement. Government stepped in to change the course of devastation of natural resources through education and scientific management.

The demand of new policy for resource management pushed a new level of capitalism. Americans had prided themselves on shaping a new nation from the raw materials of wilderness. Life had changed substantially during the 19th century, with technological innovations from the Industrial Revolution that brought new forms of transportation, such as the railways, delivering goods and services to consumers in unprecedented ways. The “autonomous individual” was born into a complex structure of mass-produced goods and services, freed from the necessity of dependence on local resources (Bowers, 2001, p. 147). This new autonomy was “essential for the expansion of

the Industrial Revolution” (p. 147) and set the stage for the beginning of globalization and the ecological crisis. The technological advancements of the Industrial Revolution created a “snowball effect” of massive inventions that quickly invaded the cultural structures and traditions of every fabric of society by altering the daily activities of people.

Many people heralded the achievements of science and technology that freed up time from menial chores and tasks that had dominated daily life. Discoveries in medicine and agriculture eliminated the poverty and disease from the past. Electricity, transportation, communication, and many other new inventions created the new market of tourism. People could spend their time and money on vacations, movies, sports, shopping, museums, and entertainment venues. People could do what they wanted, when they wanted, and spend more time on individual pursuits. Progress became the positive moniker for describing the modern age of science and technology, trumpeting the accomplishments of humans over nature.

On a global level, science and technology changed the scope of international relations through transportation and communication. When Roosevelt took office in 1901, the rise of superpowers was becoming evident, yet there was “only a rudimentary beginning of the development of international tribunals of justice” and there had been “no development at all of any international police power” (Roosevelt, 1985, p. 548).

Roosevelt believed that international police power was necessary to protect the rights of citizens against foreign invasion and, as he wrote, “it becomes a matter of sheer duty for some outside power to interfere in connection with them” (p. 548). Roosevelt believed that armament was necessary to deter foreign invasion. He used the example of the Armenian and Jew massacre by the Russians and Turks as the call to arms: “For if the

Jews in Russia and the Armenians in Turkey had been armed, and had been efficient in the use of their arms, no mob would have meddled with them” (p. 549).

Through the justification of armament, Roosevelt increased the military budget to expand the Navy. He launched a fleet of 16 battleships that traveled around the world in the course of a year. This was an unprecedented event that demonstrated to the world and to those at home how the efficient use of technology could maintain such a large operation over such a long period of time. “The coaling and other preparations were made in such excellent shape by the Department that there was never a hitch, not so much as the delay of an hour, in keeping every appointment made” (Roosevelt, 1985, p. 565). Roosevelt made a point to emphasize the military potential: “The fleet practiced incessantly during the voyage, both with the guns and in battle tactics, and came home a much more efficient fighting instrument than when it started 16 months before” (p. 566).

Roosevelt considered this the crowning point of his presidential career, “the most important service that I rendered to peace was the voyage of the battle fleet round the world” (Roosevelt, 1985, p. 563). This voyage of battleships would:

make foreign nations accept as a matter of course that our fleet should from time to time be gathered in the Pacific, just as from time to time it was gathered in the Atlantic, and that its presence in one ocean was not more to be accepted as a mark of hostility to any Asiatic power than its presence in the Atlantic was to be accepted as a mark of hostility to any European power. (p. 563)

By occupying both the Atlantic and Pacific oceans, Roosevelt demonstrated that the United States was a progressive and dominating force in the emerging stage of world powers. This new progressive explosion of technology and science created an unprecedented demand for natural resources at a time when the frontier resources had reached the depletion level. It resulted in the creation of bureaucracies to manage the

demand. According to Koppes (Worster, 1988), the three predominate themes of the Progressive Era—efficiency, equity, and aesthetics—changed the direction of conservation.

The efficiency theme was marked by a belief that scientific management could restore natural resources while supplying the demand as technology increased the consumption of natural resources. The equity theme included the idea that the management of natural resources must be done so that it benefits the whole of humankind, which meant little thought or value was given to other living organisms. The aesthetics theme called for the preservation of natural areas that were deemed significantly valuable for their pristine nature so that there would always be a refuge for those seeking respite and spiritual fulfillment.

Roosevelt created the United States Forest Service as one of the agencies to meet the challenges of the efficiency, equity, and aesthetic agenda. Gifford Pinchot had been appointed the head of the Bureau of Forestry under the previous McKinley administration. Roosevelt had worked with Pinchot on forest policies when Roosevelt was governor of New York and trusted Pinchot's judgment and vision. When Roosevelt created the United States Forest Service on Feb. 1, 1905, it was Gifford Pinchot whom Roosevelt selected as director to begin the vast national acquisition of forestlands for reserves (Roosevelt, 1985).

Pinchot gained his practical experience in forestry at the Biltmore Estate in North Carolina. He set his sights to become the head of Forestry in the U. S. Dept. of Agriculture. As a pragmatist, Pinchot guided the forest service with scientific authority and quantitative approaches (Worster, 1993; 1998; Hood, 1998). Pinchot stood as the efficiency model for the Progressive Era. Surveys of resources, harvests, and yields were

important tools used to calculate the ability of the forest to be viable. “Vigor” was a term that described the ability of a forest to maintain itself, and “treatments” were to be prescribed by the foresters to improve the condition of a forest (Hood, 1998, p. 19). The notion of ecosystem health applied only to those organisms that produced resources to benefit mankind. The “aesthetic” that had no market value was not considered important.

The preservationists, also called purists, championed the aesthetic side of nature. The Preservationist Movement, led by John Muir (1838-1914), advocated that nature had its own set of intrinsic values and the aesthetic ones were as vital as economic values. Immersion in the field of nature is a spiritual transformation necessary for human values. Immersion increases observation of the minute detail and beauty of nature and guides understanding of the human interaction within the natural world (Worster, 1993; Hood, 1998). The emphasis on the aesthetics of nature was used as a measure of an environment’s health and vitality, and there was little understanding of ecosystem functions except indirectly due to aesthetic effects (Hood, 1998).

Pinchot and Muir are classic examples of the struggle in the conservation movement between management of resources and wilderness preservation. In 1896, Pinchot served on the National Academy of Sciences’ National Forest Commission and cultivated an acquaintance with John Muir. Muir was an observer on the Commission whose purpose was to make recommendations to Congress about the future of the forest reserves. Muir proposed that the forest reserves be protected by the U. S. Army, whereas Pinchot felt forest reserves should be left to regulated use under civil government. Pinchot’s and Muir’s paths crossed several times in the future; most notably with their public sentiments over the construction of the Hetch Hetchy Dam project, proposed to

supply water for the growing San Francisco area. Muir opposed the dam, citing the loss of a pristine wilderness area. Pinchot asserted that the needs of citizens were a priority and supported the dam's construction. The dam was built and a wilderness area comprising thousands of acres was flooded (Worster, 1988).

As issues mounted about the use and protection of wilderness versus natural resource management, there was a mounting concern about the ill effects of the Industrial Revolution on the health and well-being of all individuals. Conservation became a social reform issue to get people back to the outdoors, promote public health, and restore and conserve the environment (Marsden, 1998). Nature study was a part of this social reform issue, and was formalized into school curriculums in the early 20th century largely through the efforts of Anna Botsford Comstock. As a part of the conservationist and preservationist movements, nature study "enabled children to achieve sympathy and love for all nature's forms," which contributed to a healthier society (Marsden, 1998, p. 3).

From these tensions of environmental issues and social reform emerged Aldo Leopold. Leopold stood out as a key figure from the Progressive Era who reformed wildlife management practices in ways that are still in place today. He witnessed the devastation of local resources within the context of human history and pursued a lifelong course of action to make people environmentally responsible.

Leopold's Early Career in Forest Management

Aldo Leopold was born on January 11, 1887. His family home, located in Burlington, Iowa, sat high on a bluff overlooking the Mississippi River. The Mississippi, at that time, was still a wild river and the migrations of waterfowl were abundant to witness. Leopold's boyhood reflected an emphasis on nature study and he kept detailed

journals (LP, 10-7, Box 1) on his observations of plants and animals that he continued throughout his life. Leopold's passion for nature was passed down by generations of the Starker (maternal side of the family) and Leopold families (Flader, 1991; Meine, 1988; Pyle, 2001). Leopold's father, Carl, was a "pioneer in sportsmanship" who set his own personal bag limits in a time when market hunting was still legal (Meine, 1988).

In 1905, Leopold entered the first forestry school in the United States that had been established at Yale University, a program heavily endowed by Gifford Pinchot's family. When Leopold graduated in 1909, he and his classmates assumed management positions in the newly created forest service, under Pinchot's guidance. Leopold began his career with the Forest Service serving in the new Southwestern District of Arizona and New Mexico. By 1912, he was the district supervisor for the Carson National Forest, and at this time he met Estella Bergere, who became his wife (Meine, 1988).

In 1914, after an unexpected and long illness, Leopold was forced to resign from strenuous fieldwork and worked as the acting head of grazing at the southwest Forest District 3 headquarters in Albuquerque (Flader, 1974; Meine, 1988). Grazing issues dominated the southwest district as ranchers often clashed with resource managers concerning the open range cow and sheep herds that could devastate the environmentally sensitive desert and mountain landscapes. Game protection and management was needed after the vigorous decimation of wildlife populations from the westward expansion of America during the 19th century. During this time, Leopold prepared a "Game and Fish Handbook" that attracted national attention of those in the field (Flader, 1974). Leopold's experiences in the wilderness of the Southwest made him sensitive to the

ecological degradation of the area. He had witnessed vegetation changes and erosion from overgrazing and disregard of the regional biota.

In 1924, Leopold accepted a transfer and moved his family to Madison, Wisconsin, to work for the Forest Products Laboratory, a private research business focusing on wood products (LP, 10-6, Box 1). There were indications that wildlife populations such as waterfowl were reaching critical, all-time lows. During these years, the ecological disaster from the Dust Bowl gathered public support for a more comprehensive resource policy that encompassed public and private management initiatives (Worster, 1988).

In March 1933, Franklin Delano Roosevelt became the U.S. President and reinvigorated “the Progressive-Era conservation legacy” of his cousin Theodore by immediately creating the Civilian Conservation Corps [CCC], the Works Progress Administration [WPA], and Soil Erosion Service [SCS] as a part of this comprehensive effort (Worster, 1988, p. 239). Aldo Leopold was asked by the federal government to coordinate the erosion control efforts in the southwest United States and spent that summer supervising the CCC in New Mexico and Arizona (Meine, 1988).

Leopold's Tenure at the University of Wisconsin

Upon return to Madison from the CCC, Leopold was offered the position of Professor of Game Management at the University of Wisconsin's College of Agriculture. Harry Russell, former dean of the University of Wisconsin's College of Agriculture, was the current director of the Wisconsin Alumni Research Foundation. Since 1927, Russell had discussed a game management program at the University with Leopold as director. In addition, there was discussion of establishing a university arboretum and wildlife

refuge on Lake Wingra near Madison. Leopold worked with Russell and Howard Weiss to outline the functions of a game management department (Meine, 1988).

Leopold was 46 years old when he accepted the position of Professor of Game Management on July 16, 1933, with the approved funds of \$8,000 per year for five years to support his salary, expenses, and travel (McCabe, 1987). Leopold immediately began work on “an intensive study, which is to be the basis for the national plan for the restoration of wildlife to be worked out by President Roosevelt’s committee of three, of which Dr. Leopold is one” (New York Times, 1934). (Researcher’s note: Leopold was never awarded a Doctorate degree).

The committee of three that President Roosevelt appointed also included Ding Darling and Thomas Beck. Thomas Beck was the editorial director of *Colliers Magazine* and J. Ding Darling was a newspaper cartoonist. The three developed the “National Plan for Wildlife Restoration” that helped to establish a national biological survey, and the Duck Stamp Act of 1934, which purchased wetlands from revenues generated by selling hunting stamps (LP, 10-8, Box 2).

As an agricultural college, the addition of a game management program seemed timely and appropriate, particularly with a nationally recognized authority such as Leopold directing the department. The idea of game management, however, was not warmly received by some of the academicians on the University of Wisconsin campus who considered game management to be a “bastard science, an illegitimate mingling of applied zoology and blood sport” (Meine, 1988, p. 310). In spite of criticism, Leopold’s zest and love for his field was not deterred and he began classroom instruction in 1934 creating the functions, objectives, organization, and financial needs of the new program.

Leopold quickly expanded his programs and involved himself with numerous projects. The University Arboretum, under Leopold's direction, became a living laboratory that experimented with the reintroduction of native species for land management practices (WEP, Series 3 Box 1). He agreed to serve on the newly formed game and fisheries committee for the state and worked as an extension advisor for the first national demonstration soil erosion project, the Coon Valley Watershed in southwest Wisconsin.

There were other activities from Leopold that engaged his civic duty and, demonstrated how widespread his interests and activities influenced the wildlife field both locally and nationally. He served as President of the Ecological Society of America, the Kumlein Club, and The Wildlife Society. He was Director of the National Audubon Society, vice president of the American Forestry Association, Friends of the Land, the Wilderness Society, and the Wisconsin Division of the Izaak Walton League (LP, 10-6, Box 1).

He served on committees that included the Wisconsin Conservation League, American Society of Forester, game policy commission of the American Game Association, Hornaday Memorial Foundation, Delta Waterfowl Research Station, National Council of Garden Clubs, and National Research Council (LP, 10-6, Box 1). Perhaps his most controversial volunteer duty was his tenure on the Wisconsin Citizen's Deer Committee (McCabe, 1987). On that committee he spent many hours trying to tackle the issues of game management of deer in Northern Wisconsin. The scenario played out in one of the Case Histories for Wildlife Ecology 118, Case History of Northern Wisconsin (see Chapter 4).

Leopold's contributions earned him the reputation as the eminent authority on the theory of game management. His game management theories, published in the *Bulletin of the American Game Association*, became the foundation of modern scientific wildlife management (Lorbiecki, 1996). Later, he published *Game Management* (1933), still considered one of the basic texts of the field (Meine, 1988, Knight & Riedel, 2002). Both of these publications resulted from Leopold's vast field experiences in the 20 years as a student, forester, hunter, and manager of wilderness areas. In essence, Leopold's theory of game management taught that the quality and quantity of habitat govern the number of wild animals that a given area can support; that each wild population produces a generous surplus over that needed to maintain adequate stocks; and that this surplus can be removed by hunters without endangering the species (Clepper, 1966; Flader, 1974, Knight & Riedel, 2002).

It was Leopold who influenced game management laws in the United States, liberalizing the game seasons for hunting. In *Game Management*, Leopold (1986) laid out his philosophy: "The hope of the future lies not in curbing the influence of human occupancy—it is already too late for that—but in creating a better understanding of the extent of that influence and a new ethic for its governance" (p. 21). Leopold saw the management of wildlife species as both a government and individual endeavor. Proper management of farms could restore native plants and provide the essential needs of wildlife.

The New Science of Ecology

The emerging field of ecology influenced Leopold's management ideas. Leopold's contemporaries included friend and colleague Charles Elton, a man who

shared Leopold's enthusiasm for the new science of ecology. Elton was Professor of Zoology at Oxford University and met Leopold at The Matamek Conference in Canada in 1931 (Meine, 1988). Leopold and Elton became friends and Leopold invited Elton as a guest lecturer several times over the years (Bradley Interview, 2002). Elton's theories about animal ecology are today considered to be seminal works defining the field. Elton defined ecology as "scientific natural history" and gained many of his insights about animals through his field observations (Elton, 2001, p. 1). He expressed his conviction that almost any worthwhile observation could potentially provide key insights into solving ecological problems and expresses his own enthusiasm "for having gained insight from observations of numerous aspects of biology" (p. xxi).

Elton, like Leopold, credited people who dealt in animal communities such as naturalists and fisherman for giving valuable information to ecologists. Elton referred to an amateur naturalist, J. D. Brown, who added knowledge about succession through his observations of the various wildlife species that occupied the hollow of a beech tree. As the beech tree hole grew increasingly smaller, species that occupied the hole went from owl to starling to colony of wasps.

It was Elton who coined phrases such as "food chain" and used pyramids as metaphors to depict the trophic structure and relationships of soil to grass, grass to insects, insects to bats, etc. (Nash, 1989; Elton, 2001). These concepts included "niche" as a term for describing species role within ecosystems. He pushed the idea that temporal cycles and fluctuations provided opportunities for niche differentiation and even for the existence of convergent communities during different periods of cyclical fluctuations. He

introduced the notion of parallel trophic links based on diurnal and nocturnal cycles, such as bats and moths during the night versus swallow and butterflies during the day.

Elton's diagrams on food cycles and food relations between organisms were similar to the ones that Leopold used. Elton's studies on population dynamics and fluctuations were of particular interest for Leopold. As Elton's studies advanced the field of animal ecology, Leopold applied Elton's theories to design a species management plan that would help support the preservation of wildlife. Similarities between Leopold and Elton were very striking regarding their enthusiasm for natural history and the insights gained when these observations are put into tables and diagrams. Both regarded field surveys and observational methods essential to the documentation and interpretation of species interactions.

Elton and Leopold combined their use of empirical and quantitative research to demonstrate how environmental factors influenced animal behavior. Elton emphasized gradients such as temperature and light intensity as "one way of giving some idea of the range of different animal habitats, and of the communities in them" (Elton, 2001, p. 8). Leopold used temperature and light intensity gradients as a way to incorporate phenological tables to help measure game phenomena. For Leopold, phenologies became a multifaceted way to integrate ecological knowledge across various subjects. The following four subsections discuss the multifaceted applications of phenology used by Leopold as: (a) a tool for scientific management, (b) a tool for teaching, (c) a literary tool, and (d) a tool for developing a land ethic.

Phenology as a tool for scientific management. Leopold's use of phenology is often a bridge between descriptive scientific research and literary works. The application

of phenology from Leopold's field observations was something that began when he started his tenure in 1933 at the University of Wisconsin. His phenology interest was peaked when Leopold made friends with another naturalist and contemporary, William "Bill" Shorger.

Shorger's detailed records and curiosity about the local floral and fauna caught Leopold's attention. Shorger and Leopold were members of the local Kumlein Ornithology Club, which was a hobbyist club for those interested in comparing phenology notes. Named in honor of a Wisconsin pioneer explorer, this club was composed of naturalists that were dedicated to the detailed observations of bird migrations and behavior as well as other daily, phenological happenings of plants and animals (McCabe, 1987). They identified the members of the natural community, including more than 400 records of various species of plants and animals that lived in the region (N. L. Bradley, personal communication, 04/16/2002).

When Leopold purchased the property that he deemed "The Shack" along the Wisconsin River, he began a comparison of phenology records from The Shack and from the Arboretum at the University of Wisconsin, some 40 miles away. The detailed aspect of Leopold's scientific training can be appreciated with the numerous bird song charts that he composed (see Figure 1). Nina Leopold Bradley recalls that her father would rise as early as 3 a.m. with pen and coffee in hand, sitting outside The Shack to record birdsongs (N. L. Bradley, personal communication, 04/16/2002).

Figure 1. Relationship of bird songs with photoperiods.(Leopold Papers, Charts, University of Wisconsin-Madison Archives)

These bird charts demonstrate the photoperiod effects of birdsong activities from February through October. Leopold would develop a chart for each bird and then merge them into a display for comparison. He did the same for plants, noting the average blooming periods of a vast array that included wood flowers, prairie and sand plants, weeds, marsh plants, and fruits. Animal records were included, as well as meteorological data such as the first thaw, first frosts, and first freeze. Data for 328 phenological events on different species and items were collected from and compared, then published then published by Leopold and Elizabeth Sarah Jones in *A Phenological Record for Sauk and Dane Counties, Wisconsin, 1935-1945* (1947) (Figure 2).

TABLES 1-2. Phenology for January-February.

Species, Station, Item	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	Average
1 SKUNK (<i>Mephitis mephitis</i>) Emerges from hibernation. (From Journal of Albert Gastrow.)												
Prairie du Sac:.....		2/27	2/22	2/14	3/4	1/21	2/15	2/7	1/11	1/24	2/14	2/9
2 GREAT HORNED OWL (<i>Bubo virginianus virginianus</i>) First egg (or first seen incubating).												
Dane:.....	1/25	3/11	2/13	2/24	2/18	....	2/16	2/20	2/5	....	....	2/16
Mostly from Journal of Albert Gastrow, Prairie du Sac, Wis. In 1937, 1940, 1944, and 1945 no nesting occurred in the area, though the usual number of owls was present. See Errington (7) p. 6.												
3 CARDINAL (<i>Richmondia cardinalis cardinalis</i>) First song.												
Sauk:.....	....	....	....	....	2/4	3/23	(by 3/1)	2/28	3/13	2/26	2/8	2/27
Dane:.....	2/12	1/28	1/18	(by 3/17)	1/30	....	2/16	1/20	1/24	1/13	1/14	1/26

TABLE 3. Phenology for March.

4 PHEASANT (<i>Phasianus colchicus torquatus</i>) First crowing.												
Sauk:.....	....	3/19	(by 3/31)	....	....	(by 3/30)	3/1	2/28	after (3/13)	2/26	3/8	3/5
Dane:.....	2/15	....	3/5	3/5	(by 3/21)	....	2/20	1/28	2/12	1/8	1/6	2/8
5 MARSHHAWK (<i>Circus hudsonius</i>) Migrants arrive.												
Sauk:.....	....	3/14	....	....	3/18	3/30	2/9	4/25	2/27	2/6	2/3	3/6
Dane:.....	3/6	3/1	2/25	2/11	3/4	3/17	3/14	3/8	3/20	3/2	3/8	3/5
6 WOODCHUCK (<i>Marmota monax</i>) Emerges from hibernation.												
Dane:.....	....	3/17	....	3/14	3/4	....	3/28	3/15	2/4	2/28	3/9	3/8
7 BLUEBIRD (<i>Sialia sialis sialis</i>) Arrives.												
Sauk:.....	....	3/14	3/6	3/11	(by 3/18)	(by 3/30)	3/29	3/14	3/5	3/10	3/7	3/12
Dane:.....	3/6	3/4	3/6	2/28	3/4	3/19	3/20	3/6	3/14	3/17	3/3	3/9
8 GRAY CHIPMUNK (<i>Tamias striatus griseus</i>) Emerges from hibernation.												
Dane:.....	3/13	3/18	3/13	3/19	3/14	3/31	....	....	....	3/3	3/16	3/16
9 EASTERN MEADOWLARK (<i>Sturnella magna magna</i>) Migrants arrive.												
Sauk:.....	....	3/14	3/19	....	....	3/10	3/23	3/21	(by 4/10)	(by 4/8)	(by 3/23)	3/17
Dane:.....	3/11	3/21	3/20	3/1	3/3	3/17	3/1	3/6	3/13	3/14	3/10	3/11
10 REDWINGED BLACKBIRD (<i>Agelaius phoeniceus artoleagus</i>) Migrant males arrive.												
Sauk:.....	....	3/14	....	....	(by 3/18)	(by 3/30)	3/23	3/21	(by 4/2)	3/12	(by 3/23)	3/18
Dane:.....	2/23	2/29	3/6	3/2	3/3	3/17	3/2	2/5	2/23	2/26	3/4	2/28
11 BRONZE GRACKLE (<i>Quiscalus quiscula aeneus</i>) Arrives.												
Dane:.....	3/16	3/21	3/28	3/20	3/10	3/17	3/20	3/13	3/7	3/25	3/8	3/18
12 ROBIN (<i>Turdus migratorius migratorius</i>) Migrants arrive.												
Sauk:.....	....	3/14	....	3/11	....	(by 3/30)	3/23	(by 3/21)	....	....	(by 3/23)	(3/19)
Dane:.....	3/12	3/4	3/6	3/9	3/13	3/3	3/10	3/6	3/15	3/2	3/2	3/7
13 PRAIRIE MOLE (<i>Scalopus aquaticus machrinus</i>) Active runs on surface.												
Sauk & Dane:.....	....	....	....	....	3/25	4/6	4/6	3/13	2/27	(by 4/8)	3/13	3/21
14 WISCONSIN RIVER (in Fairfield Township, Sauk County)												
Ice breaks:.....	....	3/21	3/28	3/19	3/18	3/31	3/31	3/10	3/27	3/10	....	3/21
In flood:.....	....	(by 3/29)	3/30	(by 3/27)	(by 3/31)	....	....	none	3/29	none	3/20	(3/26)
15 KILDEER (<i>Oryzopsis vociferus vociferus</i>) Arrives.												
Sauk:.....	....	....	....	....	....	4/6	....	3/6	....	(by 4/9)	....	(3/21)
Dane:.....	3/14	3/7	3/6	3/9	3/3	3/17	3/19	2/5	2/23	3/23	2/24	3/6
16 CANADA GOOSE (<i>Branta canadensis</i>) Arrives.												
Sauk:.....	....	3/21	3/24	3/11	3/31	3/30	3/29	3/7	4/3	3/11	(by 3/23)	3/21
Dane:.....	3/14	3/12	3/25	3/9	2/26	3/9	2/25	3/6	3/21	3/24	3/4	3/11
17 EASTERN MOURNING DOVE (<i>Zenaidura macroura carolinensis</i>) Migrants arrive.												
Sauk:.....	....	....	....	....	....	3/10	....	4/3	(by 4/10)	(by 4/8)	3/24	(3/23)
Dane:.....	3/16	3/12	3/19	3/18	3/21	3/21	3/23	2/21	3/24	3/24	3/11	3/17
18 WOODCOCK (<i>Philohela minor</i>) Arrives.												
Sauk:.....	....	....	....	3/11	3/25	3/30	4/5	3/21	4/4	(by 4/8)	3/15	3/25
Dane:.....	3/16	3/18	4/1	3/11	3/24	3/29	3/27	3/3	....	4/1	3/17	3/21
19 FOX SPARROW (<i>Passerella iliaca iliaca</i>) Arrives.												
Sauk:.....	....	....	3/19	3/27	....	(by 4/18)	....	4/5	(by 4/2)	....	3/23	3/20
Dane:.....	3/15	3/14	3/28	3/16	3/18	3/29	3/23	3/25	3/22	3/29	3/15	3/21
20 LEOPARD FROG (<i>Rana pipiens</i>) First seen on land.												
Sauk & Dane:.....	3/23	3/21	4/7	3/19	3/23	....	4/5	3/31	....	....	3/23	3/26
21 SPRING CANKERWORM (<i>Paleacrita vernata</i>) Adult moths ascend trees.												
Sauk:.....	....	....	....	....	....	4/6-7	3/30-4/19	3/21-7	3/25-4/9	7-4/23	3/23-4/1	3/27

Ascent is detected by trapping in rings of tanglefoot. Caterpillars descend to pupate during May.

Figure 2. Examples of phenology data by Leopold and Jones 1935-1945. (Leopold & Jones, 1947, p. 86)

These data could be used by game managers, farmers, landscape planners, and anyone who was interested in deepening their understanding about nature. Leopold compared the data to Hopkins' Law, which asserted "other conditions being equal, the variation in the time of occurrence of a given periodical event in life activity in temperate North America is at the general average rate of four days to each degree of latitude, five degrees of longitude, and 440 feet altitude, later northward, eastward, and upward in the spring and early summer" (Leopold & Jones, 1947, p. 120). Leopold's data did not quite fall so easily under Hopkins' predictions, as Leopold noted that "Hopkins seems to have derived his formula from a few plants and insects in many localities" (p. 120). Leopold said that "species respond differently to the combination of local weather and astronomic constants like length of day" (p. 120). These facts, Leopold thought, should be considered in addition to Hopkins' Law and "phenology reflects the interplay of many variable factors, rather than the continuous domination of any single factor" (p. 120).

Phenology as a teaching tool. Research in archival records indicated Leopold's interest in using phenology as a teaching tool. In 1939 the U. S. Forest Service published a phenological bulletin on plant records and Leopold was interested in expanding this bulletin to include animal records as well (Figure 3).

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

ADDRESS REPLY TO
DIRECTOR
AND REFER TO

FORT COLLINS, COLORADO

February 21, 1940.

RR - RM
Supervision
Biological Factors

Professor Aldo Leopold,
424 University Farm Place,
Madison, Wisconsin.

Dear Professor Leopold:

I am pleased to learn that your students are interested in phenology and that you have found Tech. Bull. 686 useful in your work. Mr. Price and I derived a lot of pleasure in seeing the results appear as the data were analyzed.

I am not an authority on animal phenology but I can see the desirability of such observations being kept parallel with plant records. We are not aware of any society or bureau that fosters the keeping of such records and this station is not prepared to maintain an activity of this kind at the present time. However, the idea has such a wide application that it appears to deserve further consideration.

We are taking the liberty of forwarding a copy of your letter to Mr. W. R. Chapline, Chief, Division of Range Research, Forest Service, Washington, D. C., who is in a better position to state the part the Forest Service is willing to play in furthering this activity.

Assuring you of our interest and willingness to cooperate insofar as we are able, I am

Very sincerely yours,

D. F. COSTELLO,
Assoc. Forest Ecologist.

cc-Mr. Chapline

Figure 3. Inquiry letter by Leopold regarding phenology records at the Forest Service.

(LP, Box 10)

In another correspondence to Dr. John M. Fogg, Jr., Assistant Professor of Botany of the University of Pennsylvania and consultant to the American Philosophical Society,

Leopold inquired about a new program launched by Dr. Fogg through the American Philosophical Society. The Society launched a program to engage volunteer observers to begin phenology records on local plant species in efforts to “advance science” (LP, Correspondence, 5/14/1940, Box 8)). Included in the program are instructions on how to record phenology, and a list of plant species with charts and records to be filled in by volunteers. Fogg and Leopold corresponded several times with Leopold stating, “I have been flirting with the same idea; that is, having my wildlife ecology class keep a record, only in this case it will be both plants and animals” (LP, Correspondence 5/14/1940, Box 8).

Phenology as a literary tool. Not only was Leopold interested in phenology as a learning strategy, he was curious about phenology’s influence on naturalists such as Thoreau. Sarah Elizabeth “Libby” Jones, who co-authored the phenology study with Leopold, researched Thoreau’s use of phenology. An excerpt of her letter to Leopold is as follows:

Sept. 29, 1946

Professor Leopold:

... The most enlightening part of the book for me was to discover that his [Thoreau’s] deep love of nature did not develop till around his thirties—his devotion was complete from then on, however.

While I had read *Walden* a couple of times before this summer, discovering Thoreau in the true sense of the word, has been one of the most thrilling experiences I have known. I was interested to read that in addition to the thousand of pages of the Journals must be added his broad sheets of tables in which the blooming time and locality of flowers are set down. These sheets are now in the Morgan Library and since I am planning to be at Cambridge during the Christmas Holidays I want to see if I can’t look them over and find out what compilations, if any, have been made of his phenology records (1850-1861). (LP, Correspondence, 9/29/1946, Box 8)

It was the increased use of phenology in these various ways that seemed to help Leopold expand the ideas for the nature essays. In the introduction to *A Phenological*

Record for Sauk and Dane Counties, Wisconsin, 1935-1945, readers get a glimpse of the prose that Leopold orchestrates in *A Sand County Almanac*:

Each year, after the midwinter blizzards, there comes a thawy night when the tinkle of dripping water is heard in the land. It brings strange stirrings, not only to creatures abed for the night, but to some who have been asleep for the winter. The hibernating skunk, curled up in his deep den, uncurls himself and ventures forth to prowls the wet world for breakfast, dragging his belly in the melting snow. His track marks one of the earliest dateable events in that cycle of beginnings and ceasings which we call a year.

From the beginnings of history, people have searched for order and meaning in these events, but only a few have discovered that keeping records enhances the pleasure of the search, and also the change of finding order and meaning. These few are called phenologists. (p. 1)

Aldo Leopold took his phenology records for each month and created various stories to illustrate how people, plants, and animals have interacted with each other and how they live in their community. Leopold most often used plants and animals that were familiar and somewhat common in a variety of habitats. Readers follow the skunk tracks through the snow in January; trace history through the tree rings of a “good oak;” ponder survival of a chickadee throughout the course of five years; witness the annual bloom of the prairie compass plant in a cemetery, thus painting images of days past when the compass plant “tickled the bellies of the buffalo;” and follow the annual journey of the upland plover as he completes his 4,000-mile trek from the Argentine. All of these stories and images came from Leopold’s notes and records that he witnessed in his daily records of phenology.

As each story unfolded, Leopold interjected the influence of human activity with nature, thus always putting the person into the landscape. By placing the human element within the context of the stories, the interaction of people with their environments

underscores the land ethic, demonstrating the effects of people on and with the environment.

Phenology as a tool for a land ethic. Leopold's land ethic redefined the human relationship to the Earth. Instead of the anthropocentric view of life, Leopold became the first person in the modern age to place humankind as a part of the biotic world. It is here that Leopold redefined human citizenship. "A land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members and also respect for the community as such" (Leopold, 1970, p. 204).

A Sand County Almanac (1949/1970) is a guide for citizenship to the community of all living things. To love the land and become a citizen of it requires a membership. Leopold used phenology as step toward membership for humans in the neighborhood of the plants and animals that share the community. Phenology is the first step in bridging the gap of misplaced priorities in human activities with the environment. By recognizing the plants and animals over the course of seasons, one becomes sensitized to the needs of other living things in the ecological community.

Leopold recognized that citizenship was a global responsibility because the nature of ecology has no borders. Living things are interdependent on a local level that is interdependent on a regional level that then jumps across continents and oceans. He used phenology in *A Sand County Almanac* to show the reader how the pattern of life is intricately influenced by the day to day fluctuations of weather, light, and temperature throughout the course of a year and the delicate balance of relationships becomes clear.

Phenology was used by Leopold as a tool for changing perceptions about the way humans view the world. A repeated interaction with nature by recording observations of living things on a regular basis was a priority for Leopold as a hobby, scientific method, teaching strategy, and idea generator for literary essays. Phenology was a simple task of record keeping that could be used for a variety of ways to engage people with their environments. It required people to go outdoors and observe the world around them on a regular basis. There were others who shared Leopold's love for nature and were about the increasing environmental problems. The following section examines some of the contemporaries during Leopold's life that shared and/or influenced Leopold's thinking. There were others who shared Leopold's love for nature and were about the increasing environmental problems. The following section examines some of the contemporaries during Leopold life that shared and/or influenced Leopold's thinking.

Contemporaries of Aldo Leopold

Early in the 20th Century, conservation education in the public schools gained great support through the efforts of naturalist Anna Botsford Comstock. Comstock (1854-1930) developed the first national nature study program for schools in the United States through the extension service at New York State's Cornell University. There is no indication that Leopold had contact with Comstock, but the researcher included Comstock as a reference for the conservation education programs that were in place during Leopold's career.

Comstock began her career in nature study as she illustrated insect drawings for her husband, John Henry Comstock, who was an entomologist. She illustrated more than 900 plates for his publications and was elected to the Society of American Wood

Engravers. She was also inducted into Sigma Xi, a national honor society of the sciences. Both of these honors were rare achievements for women during her lifetime. She also completed her degree at Cornell and became a professor there, which was an unusual appointment for women at that time. It was during her tenure at Cornell when her nature study program was launched (Champagne & Klopfer, 1979).

A philanthropist group, the New York Society of Agriculture, funded a nature study program for rural schools in Westchester County, a New York City suburb. The program was developed to help stimulate interest in local agriculture and slow down the mass migration of people from rural to urban areas at the turn of the 20th Century. Comstock helped develop the curriculum that was then expanded and promoted by the U. S. Dept. of Agriculture on a national basis (Comstock, 1920).

By the 1920s, Comstock had established herself as a national leader in nature study and education, developing many publications. Her *Handbook of Nature Study* (1920) was a textbook written for teachers that was popular well into the 1940s. The book was translated into eight languages and reprinted into 24 editions. Comstock created the book from the Home Nature Study Course Leaflets at Cornell that had been published for State Teacher's Institutes (Champagne & Klopfer, 1979).

In the preface of the book, Comstock gives an overview of nature education in the United States (Comstock, 1920). She credits John W. Spencer, at Cornell University, as being the first to see the importance of a national nature education program, and explains how through simple leaflets that he developed, junior naturalist clubs sprung up across the United States. More than 30,000 children corresponded directly with "Uncle John" and received a button and charter. Comstock explained her thoughts about difficulty of

nature study in the classroom: “The reason why nature-study has not yet accomplished its mission, as thought-core for much of the required work in our public schools, is that the teachers are as a whole untrained in the subject” (p. vii). Comstock goes on to add,

It is because of the author’s sympathy with the untrained teacher and her full comprehension of her difficulties and helplessness that this book has been written. The difficulties are threefold: The teacher does not know what there is to see in studying a plant or animal; she knows little of the literature that might help her; and because she knows so little of the subject, she has no interest in giving a lesson about it. As a matter of fact, the literature concerning our common animals and plants is so scattered that a teacher would need a large library and almost unlimited time to prepare lessons for an extended nature-study course (p. vii).

The Handbook of Nature Study (1920) is more than 900 pages long and is divided into four large sections. The first section contains various tips and suggestions for teachers with specific descriptions of ways teachers can integrate nature study across various subjects, such as “Language Work,” “Drawing,” “Geography,” “History,” and “Arithmetic.” The other three sections of the handbook are divided into “Animal Life,” “Plant Life,” and “Earth and Sky.” Comstock recognized the new field in evolution and dismissed its controversy among creationists by simply noting: “Also, it is very likely, that in teaching quite incidentally the rudiments of the principles of evolution, the results may often seem to be confused with an idea of purpose, which is quite unscientific” (p. vii). Comstock’s ideas paralleled Leopold’s thinking in evolution with a similar methodical and empirical approach to the study of nature. Her emphasis on the importance of field study and the identification of species is very similar to Leopold’s approach for Wildlife Ecology 118.

The new science of evolution that examined the interrelations between living organisms and created the field of ecology in the biological sciences crossed over into philosophical circles. Russian philosopher P. D. Ouspensky’s *Tertium Organum*

developed the idea of an ecological, interrelated, and spiritual organic earth, a notion that resonates well into the 21st Century. Leopold recorded in his personal notebook some of Ouspensky's thoughts from *Tertium Organum*: "But life belongs not alone to separate, individual organisms—anything indivisible is in living being" (LP, Box 1).

Ouspensky also seems to stimulate Leopold's notions about culture and its impact on the landscape and way that natural resources are used: "All cultural conquests in the realm of the material are double-edged, may equally serve for good or for evil. A change of consciousness alone can be a guarantee of the surcease of misuses of the powers given by culture, and only thus will culture cease to be a growth of barbarity" (LP, Box 1). Certainly Ouspensky's emphasis on cultural mores and consciousness resonated with Leopold's desire to teach others "to read the landscape" (LP, Box 1).

"Reading the landscape" is certainly the most descriptive method for an analysis of Leopold's pedagogy. Leopold's pedagogy is thoroughly detailed by one of his former students and colleagues, Robert McCabe (1987). According to McCabe, Leopold relied on handouts and slides as a part of his classroom lectures. Handouts often included drawings, diagrams, and sketches from Leopold's personal notebook. The lantern slides that Leopold used in the classroom came from a wide assortment of photographs, mostly from Leopold's personal collection, with a few taken from special projects by graduate students.

McCabe described Leopold's field trips with students as an "integral part" of Leopold's teaching (McCabe, 1987, p. 61). Students would accompany Leopold on trips to The Shack, the university arboretum, and wildlife demonstration areas. With a field notebook and binoculars in hand, Leopold would quiz students about various aspects of

the flora and fauna that they could observe, teaching students how to identify from a distance silhouettes of plants and trees and geographical features.

Leopold taught with patience, ease, and “an informal style that made the student feel that he was in a conversation rather than the normal teacher-student mode” (McCabe, 1987, p. 58). Under Leopold’s tutelage, McCabe obtained his masters and doctorate degrees at the U of W. Later, McCabe was appointed chairman of the Dept. of Wildlife Ecology at the U of W and remained in that position for 27 years. McCabe chronicles Leopold’s latter years at the university and details the many professional relationships that Leopold had with his colleagues. Included in this circle were well-known wildlife biologists and conservationists, such as Herbert Stoddard from the Chicago Field Museum; environmental cartoonist and administrator Ding Darling; internationally known ornithologist David Lack; and as mentioned earlier, founder of modern ecology, Charles Elton.

These outstanding pioneers in their field worked toward conservation practices to bridge the gap of culturally deviant practices that had maimed and destroyed natural resources over the past centuries. Leopold drew from examples of various cultures to demonstrate how individual choices impact ecological health over the long term and, it was one of his closest friends, P. S. Lovejoy, who helped change outdated cultural mores toward better conservation practices.

Lovejoy, like Leopold, had worked for Gifford Pinchot as a forest supervisor for the U. S. Forest Service. Pinchot’s service area had included Wyoming and Washington State. Lovejoy, who had been a faculty member of the University of Michigan, left in the early 1920s to pursue freelance writing and he wrote many articles, many of which were

published in *The Country Gentleman*. *The Country Gentleman* was owned by The Curtis Publication Company, a company that owned *The Saturday Evening Post* and *The Ladies Home Journal*. Lovejoy's articles circulated in a magazine that produced 800,000 copies a week (Kates, 1994).

The Country Gentleman was the perfect venue for what Lovejoy deemed “‘banana-peel engineering’—the placement of key ideas in places where key people were likely to slip on them” (Kates, 1994, p. 5). Through his articles he became known in his fight to reclaim millions of acres in Michigan and Minnesota that had been devastated by logging operations known as “cutovers” (p. 1). This was a radical notion at the time because there had been large scale efforts promoted by national, state, and local government and chambers of commerce to encourage farmers to settle into these cutover areas. Millions of dollars were being poured into areas that Lovejoy felt were poor attempts for farming practices and were doomed for failure. The feeling that individual initiatives and the rugged individualism of the pioneer spirit could solve the cutover problems was a leftover sentiment from the 19th Century.

Lovejoy convinced the government, farmers, extension agents, and agricultural scientists that the area needed a massive reforestation program instead. He hammered that a joint effort of governments, individuals, and private enterprise was required to solve massive conservation problems. Leopold recognized the significance of Lovejoy's efforts to turn around people's thinking that encouraged broad measures of cooperative efforts for successful conservation practices. Lovejoy's efforts resonated with Leopold and Leopold often referred to Lovejoy's witticisms and vernacular as “Lovejoyese” (Meine, p. 406). Of Lovejoy, Leopold wrote: “I believe that P.S. Lovejoy sired more

ideas about men and land than any contemporary in the conservation field” (LP, Box 10-

6). As Leopold went on to write about his friend, he described Lovejoy’s definitions

between an educator and an extension agent:

Educators smear all behaviors which are not dominantly rational. The standard campus illusion is that *Homo* can and should be educated so that he will not much, if any, (or anyway not in public) behave like a mammal. All the while everybody knows he will.

Skillful advertisers, politicians, and evangelists know in advance that most of the time people will react to stimuli and inhibitions which have little or nothing to do with the campus formula.

The extensioner splits the difference. He does not expect his customers to be much or often rational. He uses fact-logic only when it seems to work. When it doesn’t work, he contrives bait and drift-fences and banana peel arrangements which do. His job is to bridge the gap between the latest experiment stations dope and the specific action program. When the educator has done his stuff, the customer is due to be intelligent, but the extensioner is content if he thereafter acts as if he were. (LP, Box 1)

Leopold’s reference to the extensioner emphasized the extension service programs that became available for children, families, and farmers sponsored by the U. S. Dept. of Agriculture. These programs became immensely popular across the United States. Leopold developed and taught many short courses for farmers through the extension service (LP, Box 10-6). Other extension service activities included homemaker clubs and 4-H programs, all of which encouraged self-reliance and independence. The following examines the notions of self-reliance and independence as an American moniker that has wreaked havoc from an environmental perspective.

Civic Engagement through Environmental Understanding

Today there is a lack of citizen action toward environmental responsibility in the United States (Coyle, 2004, p. 13) that is affecting global living conditions. Americans consume 25% of the world’s resources (Geohive, 2005), and cause 100 times more

damage to the global environment than a person in a poor country (Ecofuture, 2004). Surveys (*Time*, 4/13/2006) indicate that Americans are somewhat concerned with the environmental crisis but do not grasp the implications. This disconnect of understanding by American citizens to the plight of others in the world is highlighted by an editorial: “The Sept. 11 tragedy compelled me to seek information, to educate myself, to try to understand why America is so hated” (Johnston, 2006). George W. Bush, John Howard, and Tony Blair indicate that those who “hate America (and like-minded nations)” do so “because of their freedoms and liberties—short because of their way of life” (O’Connor, 2006, p. 9). The purpose for this section is to highlight how Americans have abandoned their responsibility as citizens toward the environment. This section examines how American citizens contribute to the global environmental problems by examining three aspects that define Americans today: (a) their way of life, (b) disregard for civic membership, and (c) the lack of community identity.

Americans and Their Way of Life

Early 20th century philosopher Martin Heidegger noted that America was “katestrophenhaft”—the site of catastrophe—because the rampant technological frenzy in the United States had abandoned quality of life for quantity. Many think that it was Heidegger’s notion of Americanism that is the most powerful contemporary discourse. Americanism “was the most dangerous form of boundlessness, because it appears in a middle class way of life mixed with Christianity, and all this in an atmosphere that lacks completely any sense of history” (Ceaser, 2003). In creating this Americanism, Heidegger predicted many of the elements that prevail in American culture; the rise of global communication, environmental indifference, and the gluttony of consumerism.

“Consumption for the sake of consumption is the sole procedure that distinctively characterizes the history of a world that has become an unworld. Being today means being replaceable” (2003). America was the home of absorbing the unique character of place and authenticity and driving it into “the uniform and the standard” (2003).

One hundred years earlier, in 1831, Alexis de Toqueville (2001), a French nobleman and political scientist, visited America to evaluate the functioning of democracy. His conclusions were remarkably similar to those of Heidegger regarding the social, economic, and political life of the American people. The aristocracy and class system of Europe quickly disintegrated in the United States. The land owner could become anyone and a system of castes and apprenticeships that bound generations from the old mother countries was no longer necessary. Toqueville observed that land was not handed down among generations of families but divided into parcels. “Granded landed estates which have been once divided never come together again; for the small proprietor draws from his land a better revenue, in proportion, than the large owner does from his; and of course, he sells it at a higher rate” (p. 51).

Private enterprise and land development as a market commodity changed the landscape of America during the 19th and 20th centuries. The completion of the intercontinental railroad by 1870 allowed the transportation of natural resources on a large scale. In turn, competitive open markets created the rise of large businesses and corporations. Major advances in science and technology advanced free enterprise with such fervor that the frontier of the 19th century was easily abandoned for the conveniences of the growing townships and suburbs (Worster, 1988; 1993). Politics was influenced by economy of supply and demand fueled by consumer appetite. Toqueville

saw the results of such progressive interplay among individual, market, and government early on. “The people reign in the American political world as the Deity does in the universe. They are the cause and the aim of all things; everything comes from them, and everything is absorbed in them” (Toqueville, 2001, pp. 57-58).

This historic treatise implied that capitalists captured America’s appetite for gluttony in its early history using the premise of individualism and competition as the mark of a democracy. It was this competitive spirit that desensitized Americans in a race to capture global markets with the rise of mass production, starting with the Industrial Revolution. Private enterprise began to change both the American landscape and international landscape by using natural resources in a massive way. Greed became associated with the American way of life.

Greed symbolized as the “ugly American” (Burdick & Lederer, 1999) is a popular global perception, as Americans continue to use 25% of the world’s natural resources. In the past, opinion polls always indicated a degree of anti-American sentiment internationally. Current surveys show that anti-American attitudes are becoming increasingly entrenched in countries that have held negative views of the U. S. as well as among long-term, American-held allies (Speulda, 2003, p. 2). Negative characteristics that other nations associate with Americans are greed, violence, rudeness, and immorality; with Americans themselves ranking greed, as one of the most common traits. These traits changed the way Americans approached their membership as citizens of the United States.

The Disregard of Civic Membership

The embodiment of character traits such as greed is a clear crisis of “civic membership” (Bellah, Madsen, Sullivan, Swidler, and Tipton, 1996, p. xvi). In 1926, these negative traits were used to exemplify the American citizen through the fictitious character of George F. Babbitt in the Sinclair Lewis (1922) novel *Babbitt*. Babbitt’s ideas about his job were:

to make money for George F. Babbitt. True, it was a good advertisement at Boosters' Club lunches, and all the varieties of Annual Banquets to which Good Fellows were invited, to speak sonorously of Unselfish Public Service, the Broker's Obligation to Keep Inviolable the Trust of His Clients, and a thing called Ethics, whose nature was confusing but if you had it you were a High-class Realtor and if you hadn't you were a shyster, a piker, and a fly-by-night. These virtues awakened Confidence, and enabled you to handle Bigger Propositions. But they didn't imply that you were to be impractical and refuse to take twice the value of a house if a buyer was such an idiot that he didn't jew you down on the asking-price. (§, Chapt. 4)

Babbitt’s persona of self interest, civic duty, and questionable business tactics is often accepted as the American way. This culture of individualism, coined as “neocapitalism” and exemplified in Babbitt’s character, has continued to expand and invade the ideology and political structure of the United States throughout the 20th century. These traits of American citizens were explored recently in a qualitative research study published by Bellah, et al., (1996) that conducted interviews with Americans from different socioeconomic backgrounds. The study found that generally, citizens felt helpless and confused trying to define their place in modern society, often having difficulty engaging in the local community. The “neocapitalist movement” dominates the individualist ideal of America today, placing “its compulsive stress on independence, its contempt for weakness and its adulation of success” (Bellah, et al., 1996, p. xxvi).

The promise of a neocapitalist world that honors competitive ventures measured by financial gain continues to create technological advances with great cost. With these advances, humanity can now destroy all life on Earth, and with each new invention comes some environmental sacrifice, sometimes not realized until it is irreversible. Interviews conducted with middle-class Americans indicated that it was the “language of individualism” that seemed to limit people’s ideas and understanding about what they want, and that most wanted a lifestyle that was not a self-centered ideal, not a neocapitalist venture (Bellah, et al., 1996, p. 290). Yet the symbols of neocapitalist venture flourish throughout the American culture and individual life.

Symbols of cultural ideal are reflected in: (a) material objects such as televisions, cars, computers, and cell phones; (b) taken-for-granted patterns of interaction and thought and (c) intentional and reflective interpretations of everyday life (Bowers, 1996). These cultural messages reinforce the myths of neocapitalism and modernity: “that the plentitude of consumer goods and technological innovation is limited only by people’s ability to spend, that the individual is the basic social unit that makes rational and moral decisions, and that science and technology are continually expanding humankind’s ability to predict and control their own destiny” (Bowers, 1996, p. 5).

The most disturbing aspect of these cultural messages are that they are framed within a network in our languages (spoken, architecturally, and legally) and encoded to be reproduced as moral templates for understanding how individuals are to negotiate within their environments. These templates become the “culturally situated cues” that shape “culturally routine responses” passed on to future generations (Ellen, 1996, p. 29). Identity and individualism is cued with a particular choice in consumer goods and

branding. The appetite for making choices to satisfy personal gratification becomes an all consuming activity. Ultimately, these choices are promoted on such a national scale that consumer activities begin to dominate the landscape with sameness. Shopping malls, fast food restaurants, and national chains appear in the most rural of communities. As the mobile society moves from place to place, these shopping and eating venues move, too, creating a sense of familiarity and a comfort zone in a new setting. The place once identified for its unusual landscape and geographic features now protrudes a dullness of neon lights and billboards to help the misplaced wanderers of a mobile society feel “at home.”

Not only does the “language of individualism” through consumer identity threaten our sense of priorities, but the emphasis on specialization seems to distance our relationships with others. Rochelle Goedken is a nurse who recently completed three years of service as a Peace Corps volunteer for a small community in Lesotho, Africa (Theiss Interview, August 12, 2006). Working in a small, third world country, she noticed that action on local problems was embraced by all members of the community; people worked together because they had a sense of “knowing how to work together” and they “knew” their community.

In Rochelle’s view, specialization in modern society fragments people’s responsibilities—people do not respond to situations because they do not feel competent or think that others should “do it” because they are trained to handle it—even when it comes to emergencies. Rochelle thinks people “step away” from incidents when someone’s house is burning down or if someone is in a car wreck; they wait until the “professionals” arrive to treat the victims. There is no community spirit because people

do not connect to their community. Instead, they insulate themselves in their own world of specialization, incapable of reacting to instances that require any effort outside of their experience.

Wendell Berry calls specialization the “disease of modern character” (Berry, 1977, p. 19). There are, for instance, educators who have nothing to teach, communicators who have nothing to say, medical doctors skilled at expensive cures for diseases that they have no skill and no interest in preventing. “More common, and more damaging, are the inventors, manufacturers, and salesmen of devices who have not concern for the possible effects of those devices ... ” (Berry, 1977, pp. 19-20). When one specializes or focuses on one particular part, ecological understanding of interrelatedness is lost and there is a lack of communication with others across fields. Individuals become protective of specialization and begin to lack competency for taking care of day-to-day tasks.

Up until early 20th century America, competency and responsibility meant how to take care of your neighborhood and community. The “classic idea of friendship” and civic spirit in small town America involved people who “not only helped one another and enjoyed one another’s company, but also participated mutually in enterprises that furthered the common good” (Bellah et al., p. 116).

Common good in American society today is fragmented by a cycle of debt fueled by consumerism. It has little to do with the quality of life or the competency to attend to the daily needs of living within one’s community (Noddings, 1984). In a mobile society, the roles of individuals are blurred because their jobs often cross many communities as they commute distances from homes to jobs to schools, etc. What is required to attend to

life's competency is no longer understood or taught because of the rapid change in community landscape that undermines the ecological stability and cultures and traditions of the past. Jobs and markets change quickly, and people begin to expect the instability of radical changes.

The following sections explore the relationships of geography and community and how that relationship defines place and influence perceptions about the environment. These perceptions are important regarding active or apathetic response toward civic engagement.

Lack of Community Identity

A community's identity requires a multitude of factors to be considered and defined. Community can be defined on several levels (local, regional, national, and global); it is defined through physical place, and it is defined by each individual's unique experience within his or her culture. The Geography Education Standards Project [GESP] (1994) list 18 standards that students should know when they graduate from high school that encompass these various components of community knowledge applied from aspects of local to global levels. These standards are very similar to characteristics of community defined by the Environmental Protection Agency [EPA] (2002) in

Community Culture and the Environment: A Guide to Understanding a Sense of Place (Environmental P, which lists 15 components of community knowledge. Because the notion of citizenship in today's world stretches citizenship from a local to global responsibility, the researcher used these two aspects of the definitions to help broaden the meaning of components of community. Table 1 lists the components of the geographic standards and the characteristics of community knowledge.

Table 1

Comparison of Geographic Standards and Community Knowledge Components for Sense of Place

Geographic Standards Required for High School Graduates (GESP, 1994)	Community Knowledge Components for Sense of Place (EPA,2002)
Standard 1: Use maps, technology and geographic tools to interpret information from a spatial perspective	Recognize the natural, physical, administrative, social, and economic boundaries of community
Standard 2: Use of mental maps to organize information about people, places, and environments	Community Activism: What is the pool of leadership
Standard 3: Spatial organization of people to their place	How do people interact with each other and receive their information
Standard 4: Physical and human characteristics of place	What are the demographics such as age, ethnicity, sex, household characteristics, geographic distribution
Standard 5: The factors that people use to create regional boundaries	Economic conditions: types of jobs, per capita income, poverty, range of incomes, trends in employment
Standard 6: The aspect of culture and its influence on people's perceptions	Education: informal and formal opportunities
Standard 7: Interaction of atmosphere, biosphere, lithosphere, and hydrosphere that shape the earth's physical processes	Environmental awareness: perceptions of their environment: recycle, public transportation, etc.
Standard 8: Characteristics & distributions of ecosystems	Governance
Standard 9: The shift of human populations over the earth's surface and those effects	Local Identity
Standard 10: The complexity cultural influence	Leisure and recreation time
Standard 11: The network of economic interdependence	Natural resources and landscapes
Standard 12: Processes, functions, and patterns of human settlement	Property ownership and management
Standard 13: The effects of cooperation and conflict on the earth's surface	Public safety
Standard 14: The role of technology in modifying the earth's surface	Religious and spiritual practices
Standard 15: The effects of physical systems on human systems	
Standard 16: Changes in the uses of resources and the effects those changes have	
Standard 17: Using geography to interpret the past	
Standard 18: How to apply geography for present and future planning	

To clarify the definition of community, the researcher used aspects of both definitions from the geographic standards and components of community knowledge and collapsed them into similar categories in Table 2.

Table 2

Definition of Community

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1. Physical and human characteristics of places
 2. The complexity of the cultural influences of demographics, ethnicity, age, distribution, sex, household characteristics, religious and spiritual influences
 3. Local identity in terms of economic interdependence, natural, and recreational resources
 4. Ecological characteristics and interconnections
 5. Governance, leadership, and stakeholders
 6. Communication
-

In the following, the researcher explains each of the six components from the definition of community.

Community component one: physical and human characteristics of places. In geographic terms, the physical characteristics of places can include the soils, landforms, vegetation, wildlife, climate, and natural hazards that determine the character of place. But place must also include the phenomenological perspective because the way humans define their places are through experiencing them (Tuan, 1974). Studies suggest that “vicissitudes of memory go considerably beyond temporal recall and retrospection to a

significant second dimension, that of place” (Feld, 1996, p. 73). Indigenous people often use linguistic and ethnographic descriptions of place through “place-names” (pg. 75).

Steven Feld (1996) studied the Kaluli, a subgroup of 2,000 Bosavi people in Papua, New Guinea, on the way they use songs to intricately describe their interaction with the place they live in the rain forest. The ecological perspective of the Kaluli’s aesthetic sense of place is described by the Kaluli as *dulugu ganalan*, “lift-up-over sounding” (p. 68). In the rain forest of New Guinea, sounds are constantly shifting—there is no unison, “whether human, animal, or environmental,” there is a “constant textural densification constructed from a ‘lift-up-over sounding’ that is simultaneously in synchrony yet out-of-phase” (p. 69). These sounds include the birds, waterfalls, creeks, insects, amphibians, rainfall, etc., and the Kaluli construct their day-to-day living based on the environmental sounds from the rain forest. The Kaluli hear their rain forest as a “overlapping, dense, layered” (p. 70) world that is embellished in their ceremonies, dress, song, talk, work, and social functions, such that their everyday knowledge of place becomes an aesthetic description of their lives.

The aesthetic descriptions have place-names that represent a land name as well as a path description, which is an imagined symbolic geography. Song paths may meander along side waterways, follow a bird’s flight path, follow walking paths, etc. Feld (1996) has recorded more than 1,000 songs of the Kaluli that describe more than 6,000 places where the Kaluli live, encompassing an area of several hundred square miles.

Places, as exemplified by the Kaluli, are complex mix of physical and human connections. Lukerman (Relph, 1976) gives six components of place:

1. Place has location. Location is described as having internal characteristics (site) and external characteristics (situation).
2. Place has an integration of nature and culture, a “special ensemble” that makes it unique.
3. Places are part of a “framework of circulation” (Relph, 1976, p. 3).
4. Places are localized—they are part of a larger area.
5. Places have historical components that are distinctive and are emerging and becoming. New elements are added or changed by the influence of history and culture.
6. Places are characterized with the beliefs of humans thus places have meaning.

These six characteristics of components demonstrate the rich texture and multi-layered nature of place that has a very malleable interpretation influenced by space. Space is the inner part of place that also contains multiple meanings. It is defined through perception because it is intangible and derives its meaning from individual experience and understanding with a wide range of interpretations. These interpretations are defined into seven categories that are primitive, perceptual, existential, sacred, geographical, architectural, and cognitive. In some instances, these categories may overlap and interplay with each other. The following helps to clarify how each of these categories of space differs.

Primitive space is the space that gives animals, including humans, a directional sense of left-right, up-down, behind, in-front-of, etc., that is associated with body movement and senses. Primitive space crosses cultural boundaries and is difficult to distinguish between space and place on the primitive level; “a continuous series of

egocentric places where things performing certain functions or needs” are met (Relph, 1976, p. 9). Within this context, 13 archetypal places have been identified, such as “sleeping, eating, excreting, playing, or sheltering” (p. 9).

Perceptual space is the egocentric space of people that centers on practices and immediate needs and has structure. It includes that realm of emotion associated with such as sky, earth, water, mountains, and so on, as well as physical structures such as churches, courthouses, etc. For children, these places have important and lingering importance because they are part of the self discovery that takes place as children develop (Relph, 1976). This is indeed disturbing when one takes note of what types of environment most children encounter in today’s world, raising questions about present and future environmental health. “People take the natural environment they encounter during childhood as the norm against which they measure environmental degradation later in their life. With each ensuing generation, the amount of environmental degradation increases, but each generation takes that degraded condition as the non-graded condition, as the normal experience” (Kellert, 2002, pp. 113).

Existential space is the way the environments are perceived by those sharing similar experiences and living in similar localities. This is the space defined by symbols and signs that are culturally manifested. The interpretation of the environment is shaped and altered by these perceptions. Cultures are identified by the way people organize their living patterns and these patterns are reflected through the type of structures and way spaces are organized. The Cahokia people (Cahokia, 2006) identified as Mississippian Culture, lived along the Ohio River from 700 AD to 1400 AD and created large, flat-topped temple mounds, palisaded villages, and monumental architecture. There is a

ground level, circular space segmented by long poles which may have been used as a calendar to mark seasonal events. By evaluating the type of structures left by the Cahokia, archaeologists can deduce the lifestyles, political structure, economics, and belief systems of the Cahokia people. The artifacts and buildings indicate that Cahokia was a large center for trade in the Midwestern United States, and that the core of activities evolved around sun worship. At one time it was believed that between 10,000 to 20,000 people lived in Cahokia.

Sacred space is the space associated with spiritual activity and worship. In the case of the Cahokia, it was a rectangular mound that dominated the landscape of the settlement. Sacred space is where the cosmic planes of “heaven, earth, and hell are in contact with each other, and where communication between them is possible” (Relph, 1976, p. 16). These spaces can include temples, synagogues, palaces, etc., even homes where sacred spaces can be designated. Sacred spaces are often sites of pilgrimages associated with a particular event or person.

Geographical space is where humans dwell. People build to embrace dwelling because it occupies living space. Heidegger said that “man’s relation to locales, and locales to spaces, inheres his dwelling” (Heidegger, 1993, p. 359). Heidegger used an example of a family who built their farmhouse 200 years ago in the Black Forest. Their dwelling was built in consideration of the climate, on a wind-sheltered mountain slope with a roof built to shed snowfall and winter storms. The interior space was organized to include an altar, a child-bed and a coffin area “designed for the different generations under one roof,” emphasizing “the character of their journey through time” (p. 362). In Heidegger’s example of the farm family, their lives were purposely constructed with

awareness of the day-to-day and season-to-season changes that guided how they lived, what they ate, how they worked, and how they worshipped. They were grounded to their physical setting.

In relation to the understanding of geographical space to human thinking, Heidegger (1993) was concerned that modern life created a condition of homelessness where people were not grounded to their world. Learning how to dwell in the world is the essence of human life and this essence is brought to light when we, as humans, build our lives around dwelling.

Geographical space has structure both horizontally and vertically. These are existential spaces meaning they are recognizable regions or districts organized by the interests and experiences of the group they represent. Sometimes these spaces are organized by paths or buildings or open vistas and other times they may be defined as mystical, such as a stairway to heaven, a path to hell, etc. (Relph, 1976, pp. 20-22).

Architectural space differs from geographical in that it is constructed, a purposeful attempt to “create space” (p. 22). Architectural space includes planning, such as urban development. Urban development is characterized as “empty and undifferentiated and objectively manipulability according to the constraints of functional efficiency, economics, and the whims of planners and developers” (p. 23). It usually involves looking at maps and determining the efficiency of land use, often projecting future statistics regarding growth and development of a region. Cognitive space is slightly similar when thinking of architectural space, because it directs planning and design of space. However, cognitive space is homogenous, has equal value, is uniform and neutral. Projections of various maps and topographical regions as distorted figures

represented by circles or squares are examples of cognitive space. Often, abstract maps that represent overlapping regions are translated into abstract symbols to illustrate connectivity—other examples of the way that cognitive space is used.

Community component two: cultural influences. During the last century, cognitive science has been greatly influenced through studies in evolution and genetics. We know that genes are successful when they can be imitated and passed on to the next generation (Bickerton, 1996; Blakemore, 1999; Boyd & Richardson, 1985; Buss, 1999; Dawkins, 1976; 1996; Eibl-Eibesfeldt, 1989). The test of time by the environment through competition will determine how long that gene's ancestry will survive; it could be several generations or several thousand (Smith, 1982). Genetically encoded information is called phylogenetic, meaning that innate characteristics are passed on. By applying those same techniques to cultural transmission and the way we learn, ethologists have gained some interesting insights to human behavior. "Cultural evolution, therefore, is mainly a result of the forces of selection and is, to a lesser extent, the result of conscious rational planning" (Eibl-Eibesfeldt, 1989, p. 12).

This would mean that cultural evolution proceeds, as does biological evolution, as a test of survival. Often in biological evolution, there are extreme, adaptive qualities that allow species to evolve, even though they may not seem particularly advantageous. Such is the case with some people living in tropical regions in Africa. People who carry two copies of the sickle cell anemia gene suffer horrible pain and die young, and people who carry two copies of the "normal" gene are at high risk from death from malaria. But those who carry one copy of the sickle cell anemia gene and one copy of the "normal" gene are protected from both malaria and sickle cell anemia. "Where malaria is

prevalent, such people are fitter, in the Darwinian sense, than members of either other group” (Nesse & Williams, 1998, p. 91).

All people share the same biological structures and use the same senses, yet environments can finely tune our perceptions so that we make adaptations that separate us through our culture. Eskimos must rely on their senses to adjust to a constant state of change and “learn to adjust” accordingly (Tuan, 1974). There are times during the year in Artic regions when the sky and earth seem to merge as the snow and gray sky meld into one landscape. It is during those times that an Eskimo must rely on the “direction and smell of the wind” and the “feel of the ice and snow under his feet.” The Eskimo’s language includes at least 12 different descriptions for the varying winds and numerous other descriptions for snow (p. 11).

The unique character of the environment distinguishes cultures. The influence of activities and stories that represent symbols from a particular culture are passed on to the next generation. The world of the young child is shaped by the themes and stories that occur in the “context of stories he tells himself. These are transfigured by versions of his experiences in a world ruled by adults of tales told by them, and bits of conversation overheard. His activities and explorations, then, are increasingly directed by cultural values” (Tuan, 1974, p. 12).

In the past, cultures were created from the influence of the local environment. Foods, clothing, and shelter, such as those of the Eskimo, were constructed from the direct contact with the natural resources at hand. Words described the native plants and animals experienced at a particular locale. Daily living was organized around the seasons and climate. As cultures began to expand, people carried their trade, their traditions, and

foods preferences while adapting themselves to new environments (Fukui, 1996).

People, up to the middle of the 20th century, were still somewhat dependent on the local community to fulfill their daily work, leisure, and home activities.

In the last 60 years, technology and industry divided daily living into “separate functional sectors: home and workplace, work and leisure, white collar and blue collar, public and private” (Bellah, et al., 1996, p. 43). Goods and produce that provide daily sustenance and needs may travel across the globe to reach the average family. The changing global market of technological invention has created a global workforce that moves and guides people’s lives to new locations on a regular basis.

Even though the global workforce drives the migration of people, the notion of pursuing “the American dream” is still a powerful icon. The concept of free enterprise, “where each pursued his own self interest”—that each person pursuing his [or her] own self interest automatically results in “social good” for society (Bellah, et al., 1996, p. 33)—has dominated the thought of Americans since the country was founded. However, the lure of pursuing “private economic pursuits” isolates individuals from their community, particularly when work and play are divided into different communities. Toqueville coined the term “individualism” from his observations when he visited the United States in the early 1800s (Bellah, et al., 1996) and questioned the future of a democratic nation where self-interest was the dominant pursuit.

The way to avoid the greed of self pursuit is through civic engagement with the local community. Toqueville used the example of the 19th century small town community where people actively pursued their dreams yet worked with each other in the spirit of civic engagement to improve the quality of life within the culture of their

environment. "... The town was a moral grid that channeled the energies of its enterprising citizens and their families into collective well-being" (Bellah, et al., 1996, p. 39).

The moral grid of American culture today is in a state of confusion. As the standard of living has increased, there has been erosion in our sense of well-being even though we are living longer with more luxuries than ever before. Surveys (New Road Map Foundation, 2002) indicate that despite increasing economic growth, Americans "feel" significantly less well-off: despite the increase in consumption (45% increase), the quality of life has dropped (51% decrease). Since the 1960s, American parents spend 40% less time with their children, spend 163 more hours on the job per year, and watch 39% more television. These surveys also targeted college freshmen and indicated that financial security (32% increase) was more important than a philosophy of life (44% decrease). Overall, the same surveys indicated that in the last 40 years, Americans spend six hours a week shopping, making close to 50% of purchases on the spur of the moment. Ninety-three percent of teenage girls report that store-hopping was their favorite activity.

The homogenous activity of consumerism seems to engulf the values and unique spirit that each race and culture of people bring with them as they become citizens in the United States. The "kind of life we want depends on the kind of people we are" (Bellah, et al., 1996, p. xli). George Ritzer (2004) discusses the globalization of consumerism and its affect on American culture using "MacDonaldization" as the standard that is changing the world. As of 2003, there were more than 13,000 McDonald's restaurants in the United States with a total of over 31,000 McDonald's restaurants worldwide in 118 nations, serving 46 million customers a day (p. 3).

According to Ritzer (2004), the widespread popularity of fast food restaurants and mass production of consumer goods epitomizes early 20th century philosopher Max Weber's theory of rationality. Weber describes the modern Western world as a world dominated by "efficiency, predictability, calculability, and nonhuman technologies that control people" (p. 25). These characteristics are similar to those mentioned previously describing the Progressive Era, but differ because Weber foresaw the use of technology as a dominating factor. "Formal rationality" means the search for the optimum to a given end "is shaped by rules, regulations, and larger social structures" (p. 26). There are four dimensions to rationality: (a) bureaucracy is the most efficient method for handling large numbers, (b) quantity is more important than quality, (c) output is highly predictable, and (d) people are controlled by bureaucracy through a series of rules, regulations, and policies (pp. 26-27).

The result of rationality is that society tends to become irrational as rules, regulations, and mass production create more problems than they can solve. Mass production results in the demise of privately owned businesses such as restaurants and farms, and creates huge environmental problems, such as frequent *e. coli* contamination in spinach and beef produced by large scale operations. Yet people are making more and more choices for what Ritzer (2004) describes as "nothingness" rather than "somethingness," because "nothingness" is an easier choice as people try to navigate and multitask during the course of a modern workday. The conveniences of "nothingness" are defining the symbols that dominate the cultural landscape in the modern world.

The evidence of cultural transmission as a powerful adaptive mechanism has "no doubt exceeded the biological ones in importance" (Eibl-Eibesfeldt, 1989, p. 15). Most

often cultural transmission proceeds without direction and, like phylogenetic adaptations, the selected traits will be passed on to future generations. If cultural transmission proceeds too rapidly, it can have disastrous results. “Progress depends on the balance achieved between the preserving ‘conservative forces,’ and those promoting change” (p. 15).

We use our customs and traditions from our past as a firm base from which to experiment with new ideas and change. When we proceed too rapidly, change becomes dangerous, much like the rapid mutation of a virus that destroys everything in its path until it, too, becomes extinct. As the community of consumerism continues to feed the individual appetite for self-fulfillment, one tends to speculate on American way of life as a successful future model.

Community component three: local identity. The experience of our surroundings in our community has a profound impact on “our sense of self, our sense of safety, the kind of work we get done, the ways we interact with other people, even our ability to function as citizens in a democracy” (Hiss, 1990, p. xi). As places change, we change. The experience in place is both “a serious environmental issue and a deeply personal one” (Ibid.).

Some of the effects of these changes are directly in conflict with our biological makeup. Carl Jung (1993) reminds us that when looking at the timetable of Earth’s history, humans have only occupied a very brief period, with only 80 generations separating modern humans from our ancient ancestors. “It would be a ridiculous and unwarranted presumption on our part if we imagined that we were more energetic or more intelligent than the men of the past—our material knowledge has increased but not

our intelligence” (p. 300). Cultural ethologist Eibl-Eibesfeldt says that today “people with the motivations and intellectual capacity of late upper Paleolithic man are flying jet bombers and confronted with the task of surviving in anonymous society” (Eibl-Eibesfeldt, 1989, p. 15).

The most distinctive change from our past to the modern world has been the shift from the outdoor to indoor environment. Following the postwar period of WWII, the workforce of Americans in the last 60 years has shifted into an indoor environment. Artificial light, heating and cooling, manmade building materials, dependency on computers, copiers, and communication systems have desensitized our bodily functions (Relph, 1976). Even though we are still the same species that evolved from a rich, organic interdependent environment, we have moved ourselves into a sterile, monotone, and environmentally regulated comfort zone that provides little stimulus for our senses.

The objects we tend to perceive as humans are commensurate with our purpose (Taun, 1974). Modern living requires less reliance on acute senses, which tend to be dulled by a bombardment of strong scents and white noise. Sense of smell is diminished with the various manmade fumes that pollute our air—perfumes, exhaust fumes, cleaning supplies, air fresheners, deodorants, etc., creating an olfactory haze. Noise perpetuates and invades space: Boats speed down rivers, sounding like jet airplanes; boom boxes from cars can be heard a mile or more away; background noise from the beeps of construction to the hum of the interstate fill modern living. Temperature is controlled by the push of a button or movement of a knob.

These daily components of modern living are incorporated into our subconscious where nearly all learning takes place (Taun, 1974). The pervasion of the human made

environment replaces the need to become familiar with the natural world. If we do not “need” to know the names of the plants and animals that surround our community, then we tend to ignore them and soon forget them. We may see the bushes and trees and insects and birds, but do not finely tune ourselves to identify their unique features or names—we disregard their whole function as a part of the same, interrelated ecosystem that we depend on. “In short, landscapes change their identity according to the way in which we experience them” (Relph, 1976, p. 133).

As communities are urbanized, the unique features of a region dissipate and become engulfed with no center, no direction, and with a multitude of changing purposes. The unspoiled familiarity of a particular landscape changes into a neon buzz of distortion that continues to change each year. Some say this identity problem quickly shifts over to individual identity. Coined as ‘Protean Man’ by R. J. Lifton (Relph, 1976, p. 133), the modern individual shifts and changes lifestyles from decade to decade, going from radical student to conservative businessman to the concerned activist. This is a major shift from the traditional view that “each individual should present a consistent and stable identity throughout his life” (p. 133). When the boundaries and consistency are not clear, then relationships become contorted. “For example, nuclear weapons do not distinguish between citizen and soldier, the guilty and the innocent; mass media overwhelm us with indiscriminate images that mix reality and fantasy, enjoyment and blatant commercialism; modern international corporations are monolithic yet formless, they interpenetrate all aspects of our lives, changing their style freely to fit the particular product that is being marketed” (p. 134).

Proteansim becomes the prevailing feature of built environments. Buildings and consumables change so quickly that styles are out of style before they become worn out. This year's landmark skyscraper is soon replaced by the next year's landmark skyscraper. Architectural and landscape features are less indigenous so that as these protean changes increase, landscapes and local identity decrease (Relph, 1976). These new images of landscape are a break of the landscapes from our past because they do not fit a pattern. Pattern recognition is a basic, cognitive skill that helps people to bring order into their worlds (Piaget, 1968; 1970; Burton, 1993; Barkman, 2000; Decampo, 2000; Volk, 1995). As uniformity and obscurity dominate the new modern landscape, lacking pattern and form, the whole state of identity with place and one's self becomes confusion.

The confusion of symbols with places is such an example. At one time, symbols expressed a profoundness and attachment to a particular place. Traditional cultures valued attachments to places because of the symbolic tie that usually involved a form of participation by a particular culture with a place. Today, symbols tend to broadcast a set of ideas that are "contrived and deliberately fabricated" (Relph, 1976, p. 137). Places are advertised with signs of various colors and words that immediately indicate to the passerby their significance. A gigantic neon cross indicates a fundamentalist Christian area, outlines of naked women and flashing red lights indicate promiscuous places, life-size plastic dinosaurs and cartoon characters indicate amusement parks. "The new landscape is characterized not by profound meanings and its symbols, but by rationality and absurdity and its separation from us" (p. 139). The identity with place today does not hold the same reverence or attachment has it has in the past. "A deep human need exists for associations with places. If we chose to ignore that need, and to allow the forces of

placelessness to continue unchallenged, then the future can only hold an environment in which places simply do not matter” (p. 147).

Placelessness challenges our potential to develop within ourselves. One of the most prominent behavioral scientists of the 20th century, Zing-Yang Kuo (1967), conducted many different studies on animals that are considered classical treatises. One of the most interesting was his study raising baby birds that were not “taught how to fly.” When the bird did not have to fly, he did not acquire a behavior of flight pattern, even though flight was not inhibited or restricted while other patterns were being developed and fixated. “This failure to form an actual flight pattern is not due to a lack of appropriate stimuli for the ‘instinct of flight’ neither at its ‘critical period’ nor to a lack of exercise or of strength in the neuromuscular system for flight, for many could fly when frightened by the chasing dog” (p. 175).

Kuo demonstrated that “ the combined factors of developmental history and environmental context alone are often sufficient enough to reduce the range of behavioral potentials, a reduction that does not necessarily involve anatomico-physiological factors; it is a reduction of plasticity in the formation of new patterns without any need for reference to mythical predetermined neural organization” (Kuo, 1967, p 175). As landscapes are continually being reduced to placelessness, the reduction of plasticity from an environment rich in organic context to one that protrudes sameness offers little challenge for extending the possibilities of human potential.

Community component four: ecological characteristics and interconnection; Earth Mother, Darwin, evolution, Ouspensky, Gaia. Examples of humans living within the context of a rich organic ecological environment can be studied by examining the

ancient pantheons of human history. Some of the greatest accomplishments of human history were endeavors that centered on the worship of the feminine traits and goddesses that seem to create a cooperative, nurturing, and peaceful society.

Through her life's work, archeologist Marija Gimbutas (1999) has included excavations from more than 3,000 sites including Obre in Bosnia, Anza in Macedonia, Sitagroi in northwestern Greece, Achilleion in southern Thessaly and Manfredonia in southern Italy. Excavated from the Paleolithic and Neolithic periods are female forms with enlarged breasts and buttocks and sometimes swollen vulvas. Rather than denoting eroticism, Gimbutas believes the figures represent fertility and are a life-giving symbol in which birth is considered sacred. Goddess and god figures were also associated with animals whose special properties can symbolize life, death, fertility, regeneration, etc. Waterbirds, snakes, and birds of prey seem to be the most popular figures; however, snakes, bears, frogs, rams, pigs, dogs, boars, birds, hedgehogs, etc., all played a part in religious symbolism. Often, masks were used that depict goddesses and gods with special features of these animals.

The annual cycles of agriculture, which provides sustenance, were associated with a vegetation goddess and god. A pregnant vegetation goddess, Earth Mother, was one of the most represented figures found in sites throughout old Europe. It is easy to understand how the Earth Mother would be extremely important to these early agriculture societies. It is the first time that human cultures began to exist in fairly large groups and "city-states" (Gimbutas, 1999). The cycles of planting, growth, and harvest would be so important for sustenance.

As societies became more sophisticated, the evidence of goddess worship is found in all types of ancient communities, such as Jericho and Catal Huyuk. Special attention is given to burial sites of women, some of which are painted with red ochre. Additionally, figurines are often found in threes, depicting the goddess as young woman, mother, and old woman. At some point in time, a male figure appears and seems to be associated with the female goddess as her son, husband, or lover. This male god always appears in a lesser role and traditionally, when the male is depicted as a youth, becomes involved in a sacred annual sexual union (Gimbatus, 1999).

The female goddess was a very dominant and widespread figure in ancient cultures. Until the invasion of the Indo-Europeans into the ancient Mediterranean, women attained or were on equal status with men (Stone, 1976). Women were often economically independent, appeared as parties in civil litigations, and conducted business transactions. In Egypt, women were often sole heirs; in Crete, the goddess was the “core of existence” (p. 47). The balance of government and power was shared by both men and women. Living conditions were more peaceful and enhanced by the fertile soils and moderate climate that produced abundant crops. It was a culture that embraced the interrelationships of humans with their environments.

The invasion of the Indo-Europeans that began in 2400 B.C. and occurred gradually over several thousand years radically changed the peaceful cultures of the ancient Mediterranean. Gimbatus (1999) identifies the Kurgan culture as the predecessors of the Indo-Europeans and believes the Kurgans originated from the steppes of Russia. These cultures were striving to survive in the harsh climates of the steppes and included hunter/gatherer types and pastoralists, both with a patriarchal society and

dominant male god. Their sustenance required them to move over large areas. They had domesticated the horse and used military tactics for invading areas, earning them the title of “Battle-Axe” cultures. Conflicts over land were critical. Studies by ethologists indicated that “encroachment on land” was twice as frequently the cause of warfare as stealing or murder (Eibl-Eibesfeldt, 1989, p. 4).

When Indo-Europeans began to migrate to Europe and the Middle East, they must have been delighted and intrigued to find such advanced societies. The agricultural societies would have been very attractive. The barbaric lifestyles of the Indo-Europeans would have been appalling to the old Europe societies and their ability to take over these more peaceful cultures would have that the Indo-European male deities were certainly more important and more powerful than the goddesses.

Gimbutas (1999) identified three waves of migration of the Kurgans into Greece, Italy, Britain, Ireland, Iran, Lithuania, Latvia, Germany, Scandinavia, Anatolia, India, and Chinese Turkestan. The time frame of these migrations occurred from 4400 B.C to 2800 B.C. Gimbutas compared the Old Europeans and Kurgan cultures and found great disparity. Old European cultures lived in large, well-planned townships, absent of fortifications and weapons. Their ideologies were agricultural, seasonal, matrifocal and matrilineal based. The Kurgans, in great contrast, were warriors who worshiped thunder gods and glorified the blade. The Indo-European social structure is one of class society of the sovereign, warrior, and laborer, which is in great contrast to the social structure of Old Europe. Artifacts from Old Europe gravesites indicate there is not a strict division of labor nor does there appear to be a great division of classes.

Blood typing from gravesites in Old European cemeteries indicates adult females and children were related but males were not. This indicates a matrilineal society where mothers and daughters maintain residence and ownership of property (Gimbatus, 1999). Excavations of Kurgan sites reveal abstract images of gods represented by weapons with divine animals such as a horse or stag. The “organized slaughter of human beings, along with the destruction and looting of their property and subjugation and exploitation of their persons, appears to have been normal” (Eisler, 1987, p. 49).

The rise of the three religions of Judaism, Islam, and Christianity, rooted in the symbol of the father of Abraham, became the ultimate demise of goddess worship. This was also the ultimate demise of women and their rights of personal freedoms. The biblical story of Joshua marching into the land of Canaan demonstrates some of the first large scale “ethical cleansings” in human history (Stone, 1976). “And so Joshua defeated the whole land, the hill country and the Hegeb, and the lowland and the slopes, and their kings. He left none remaining, but utterly destroyed all that breathed, as the Lord God of Israel commanded” (Joshua, 10:40). This story celebrates the brutal massacre of peaceful civilizations, with the rise of privileged, male dominated groups such as the Levites, whose self-appointment as God’s anointed used terrorist threats to dominate and control people who were in their path. Virginity of the unmarried female and strict sexual restraints upon married women was the way that males could obtain ownership of name and property.

Even though goddess worship has persisted over the years, those who followed the practice have been punished. Eventually “the contact between the Old European and Indo-European cultures resulted in their amalgamation” (Gimbutas, 1999, p. 129).

Deities, beliefs, customs, and traditions have merged into one for the most part as male dominated. One culture's myth became incorporated into a new culture's myth, with perhaps different names of characters, players, or gods (Campbell, 1993; Jung, 1993). The more one compares the cultures, the more obvious archetypes can be seen across cultures of many different races.

The hope of returning to a feminist ideal of a Mother Earth archetype that embraces a culture to nurture and sustain life began with Darwin's theories of evolution. On July 1, 1858, Darwin presented a paper along with manuscript from Alfred Russell Wallace to the Linnaean Society. *The Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* sold out the first day. The paper contained two separate theses: that all organisms have descended with modification from common ancestors, and that the chief agent of modification is the action of natural selection on individual variation (Darwin, 1998).

Darwin ethnocentric theories placed humans within the realm of a living, interconnected organic relationship with all life on earth. No longer were humans a divine intervention with appointed dominion (Demasio, 1994). From the years that followed Darwin's theses, the next 100 years revealed the sensitive and closely evolved characteristics of human behavior and biological connections with other living organisms. These associations are highlighted in the following discussion summarized from John Maynard Smith's *Problems with Biology* (1986).

Scientists, such as G. Hardy and W. Weinberg, with their independent proof theorems, gave strength to Darwin's theory. These theorems were expanded by

Ronald Fisher (1890-1962), John Haldane (1892-1964), and Sewall Wright (1889-1988).

Fisher in *The*

Genetical Theory of Natural Selection (1930) and Haldane in *The Causes of Evolution* (1932) developed the mathematical theory of gene frequency change under natural selection, showing even slight differences could bring change. Wright developed comprehensive genetical theory that embraced selection, inbreeding, gene flow, and effect of chance (random genetic drift).

Elements of theoretical population genetics on variation and species were synthesized in 1937 by Dobzhansky's *Genetics and the Origin of Species*. Ernst Mayr in *Systematics and the Origin of Species* (1942) elucidated the nature of geographic variation and speciation, incorporating many of the genetic principles articulated by Dobzhansky. Gaylord Simpson (1902-1984) in *Tempo and Mode in Evolution* (1944) and its successor, *The Major Features of Evolution* (1953), drew on Dobzhansky and Wright.

Between 1947 to 1980, more theories began to surface as knowledge of genetics and DNA expanded. Fisher (1930), Wright (1968), and Haldane (1949) showed that even a slight selective advantage could bring about fixation of an allele. Dobzhansky (1937) added that some natural polymorphisms were subject to appreciable selection, no matter how slight the adaptive significance.

V.C. Wynne-Edwards (1962) argued that dispersal of animals evolved because it relieves population density and so benefits the population as a whole, rather than individual members. Controversy then arose about whether such altruistic traits could evolve by natural selection at the individual level, or whether group selection, evolution

by the differential extinction, or proliferations of whole populations was necessary. Among the most influential contributions to the debate were those W.D. Hamilton (1964), who articulated the theory of kin selection as an explanation of altruistic behavior, and G.C. Williams (1966), who argued that group selection is such a weak force that alternative explanation for altruism should be sought in selection at the level of the gene, the individual organism, or the kin group.

The enthusiastic response to these proposals ushered in an era of analysis of the adaptive value of puzzling traits, especially features of life histories and of social behavior. Perhaps the most important research on social behavior has occurred from the work of ethologists over the last 30 years. Ethologists began to show that animals, even the most simple, such as guppies, can imitate behavior and make choices based on that imitation.

Dr. Lee Alan Dugatkin (2000) was the first to demonstrate this imitation behavior in a controlled study on guppies. Using two female and two male guppies, Dugatkin allowed one female (the observer) to view the second female (the model) choose between two males for mate selection. In 17 out of 20 trials, the observer female chose the same mate as the model.

To further investigate the effects of behavior from one guppy to another, Dugatkin wanted to test the protocol of “age/imitation/mate choice”(Dugatkin, 2000, p. 61). In one treatment, young but sexually mature females were observers with older, more experienced females serving as models for mate selection. In other treatments, the experiments were reversed, with older females as observers and younger females as models. The results indicated that “when young impressionable females were the

observers, they copied the mate choice of others. On the other hand, when the experienced lot observed the youngsters, they went about their mate-choice activities regardless of whom they saw the younger females choose” (Dugatkin, 2000, pp. 61-62).

During the last 40 years, ethologists have been steadily accumulating research on cultural transmission of animals in the wild. The primate studies started by Dr. Jane Goodall at the Gombe Preserve in Africa are now almost 40 years old. More than 65 behavior patterns have been identified in chimpanzees that demonstrate the acquisition of tool-use and technology for various activities such as food processing, grooming, socialization, etc. “Chimpanzee populations exhibit considerable cultural variations with learned group traditions that parallel traditional human societies technologically”(Standford, 1998, p. 401).

The evolutionary studies ranging from genetics to ethology since Darwin’s discovery continue to illustrate the close associations of organisms to their environments and intricate levels of learning that take place within. The ecological framework where these actions occur suggest a web of life (Capra, 1996) where consciousness and environment become intertwined, much like the ancient civilizations of Earth Mother described by Gimbutus (1999). By the early 20th century, philosophers, such as Russian P.D. Ouspensky, grasped the implications of evolutionary theory as a theory of living Earth, that both the inanimate and animate are nature and “that each thing, each phenomenon, possesses a psyche of its own. A mountain, a tree, a river, the fish within the river, dew and rain, planet, fire—each separately must possess a psyche of its own” (Ouspensky, 1920, p. 199).

Nature, in Ouspensky's views, consisted of a unity of organic life that included the entire universe as alive, believing that humans were "some kind of life in progression" but certainly not a "quintessential creation" of a divine being (Presley, 2003). James Lovelock (1979) describes an equilibrium that Earth has established to maintain a balance of life that continually adjusts itself from trial and error. Lovelock's theories on Gaia are based on the perspective of the view of Earth from space, "revealing the planet as a whole" versus the ecological view which is "the detailed study of habitats and ecosystems" (Lovelock, 1979, p. 118). From Lovelock's perspective, "Gaia is Earth's physiology: the sum of the energy- and material-exchanging activities of the living network at our planet's surface" (Margulis & Sagan, 1997, p. xxi). Looking at the whole system as well as applying ecological knowledge can help to synthesize the steps that citizens can take toward improving their own communities. David Orr terms this approach *ecological literacy* (Orr, 1992).

Ecological literacy combines geographical and "conceptual streams" that include "systems theory, systemic school reform, place-based education, and the wisdom of indigenous people" (Capra, 1999, p. 13). This means that the world is a connected whole that involves a process of networks influenced by context and quality.

As children mature into adults, ecological knowledge is obtained by direct contact with the natural environment on a regular basis. This involves concepts whereas: (a) all members of ecosystems are connected; (b) there is a multileveled structure of systems within systems while each system is part of a larger whole; (c) resources are exchanged in continuous cycles through partnership and cooperation; (d) solar energy flows through and sustains all levels of life; (e) life evolves through the interplay of creativity and

mutual adaptation; and (f) the ecological community constantly adjusts itself to environmental conditions through feedback loops (Capra, 1999).

Many of the problems of placeness and greed (Relph, 1976) associated with modern society could be solved through “the possibility for fulfillment and self-realization” that is “found in our relationship with the diversity of life around us” (Kellert & Wilson, 1993, p. 456). Ecological literacy embraces the discoveries of evolution in which both the phylogentic traits (biologically inherited) and cultural traits are intricately tied with environmental relationships.

The knowledge of the past endeavors from ancient to recent history provides a guide to set goals for the future of cultural development. People of ancient civilizations celebrated their lives with earth symbols and mythical figures, “half human, half animal” who “served as tutors to humanity” (Orr, 1992, p. 79). A sense of aesthetic guided the endeavors of ancient people in governance, literature, art, and daily living. The ideal was embraced with a feminine Earth Mother who received prayers and gave protection from physical and spiritual danger, protected crops, livestock, guarded children, and watched “over the sailor at sea and the merchant on the road” (Campbell, 1993, p. 139). The governance required for ecological literacy involves a passion of nurturing and caring, a feminine approach that provides a cooperative spirit for solving problems (Gimbatus, 1999; Noddings, 1984; Stone, 1976).

Community component five: governance, leadership and stakeholder. Governance is the formal process of decision-making from the local to national government level. Governance begins with civic identity, a principle based “on freely given commitment to certain civic principles and values of the democracy” (Patrick, 2006, ¶). These civic

principles are agreed upon through consensus and include duties and responsibilities such as paying taxes, serving in the military in times of crisis, obeying laws enacted by representation in government, and constructively criticizing the conditions of political and civic life and improving the quality of life. For a democracy to work, citizens must exercise their rights of citizenship by participating in the process of government.

The process of government begins at the grass roots level through community capacity. The community capacity is the pool of leaders, elected and appointed, who influence the community decisions on behalf of a particular group or the whole community (EPA, 2002). Activism and community capacity are demonstrated by groups that organize themselves to track or work on particular issues and to inform the community. Activism is often “practiced through local demonstrations, meetings with local officials, and informal meetings among community members” (EPA, 2002, p. 53). Activism and community capacity also describe the “capacity of new leaders to emerge within the community, opportunities for empowering community members not previously involved with community decision-making (e.g., minority groups), and the ability of the community to work collectively to create and sustain beneficial change” (EPA, 2002, p. 53).

There are three levels of politics and citizenship in a democracy (Bellah, et al., 1996). Community capacity is the first level of politics and citizenship and is the local level where individuals interact directly with each other to improve local quality of life. The second is the politics of self-interest groups organized to represent a group’s particular concern. Self-interest politics are regarded as negative because the group is seeking support for self-interest of the group and not particularly for the well-being of

society. This type of politic is competitive and exerts inequality as it pursues power and influence. The expression of individual support usually takes place in the voting booth and lacks the immediate attention of everyday living.

The third politic is the one of national interest where people identify with the national political party that best represents their own, individual ideals of democracy. The national parties are for the most part perceived as positive symbols of national identity. Symbols of national identity are expressed through a variety of public rituals, identified by objects such as flags, historic figures and places, and through foreign policies and involvement in wars. Through consensus of political parties, individual acts to support national policies are expressed by the “consensual community” (Bellah, et al., 1996, p. 202).

The fourth politic that Bellah, et al., (1996) have not addressed but is emerging in the 21st century is global politic. The politics of present and future involves a clash of values between nations where fundamentalist groups challenge traditionally held beliefs. Global politics that include military interventions, diplomatic offensives, and laws that deal with sovereignty of states over the rights of peoples widened the task of reaching satisfactory resolve toward solving immense problems of poverty, civil rights, and ecological disasters. A global society must work on a common vision that embraces an ethic to encompass and value cultures and religions. The ethic must include responsible leaders that are not modeled from the archetype of the aggressive, warlike hero in the past whose “ecological perspective has been to expand a particular society’s niches, increasing opportunity, geography, resources, population, and energy” (Orr, 1992, p. 78).

Global leaders must exhibit patience, compassion and understanding that emerge through the “discipline of learning to listen, first” (Orr, 1992, p.79). This type of leadership has been modeled by great figures in our past with attributes detailed across cultures. “Peace and quietude are esteemed by the wise man, and even when victorious he does not rejoice, because rejoicing over a victory is the same as rejoicing over the killing of men” (Tao The Ching, Stanza 31). This model of global leadership should “reflect the sensitivity of a global ethic that offers a minimal moral stimulus which the world must observe in its manifold efforts to overcome the global problems ...” (Dower & Williams, 2002, p. 137). The ecological crisis is perhaps the most imminent threat of global magnitude that requires transformative leadership (Orr, 1992, p. 79). Transformative global leaders are those whose “loyalties are rooted in place but extend to the planet” (p. 79). Yet, in a world where place is a center of orientation for rootedness, it becomes increasingly difficult to establish firm ground (Hess, 1990; Relph, 1976; Taun, 1974). Civic participation on a roots level is in need of “restoration” (Titus, 1994) as reflected by individual participation in election polls.

Democratic participation is on a decline as the polls reflect that only half or less of the eligible population in the United States votes (Orr, 1992). “Politics is the process by which we define the terms of our collective existence” and when less than half of the American population fails to do so, it means that people “no longer see a relationship between their lives and the political life of the larger society” (p. 75). The centralization of power in government has “removed many of the local resource decisions away from the public arena” (p. 76) and have placed the manipulation of resources into the hands of large corporations with machines that can “level mountains, divert rivers, split atoms and

alter genes” (p. 77). Citizens become apathetic to conditions that seem out of their control creating a crisis of civic identity.

This apathy of civic identity is created by the “rapid cascade of change” along with complex problems from local to international levels and the “amount of disinformation in advertising and public debate” (Titus, 1994). Change, including the uncertainty of job security, means that long-term community commitment and civic identity is never a reality. Efforts to convey the idealistic notion of self-service to the community are overwhelmed by the large scale corporations and institutions that shape the individual’s work, lifestyle and choice of living place (Bellah, et al., 1996, p. 199).

To be successful in work means that individuals must succumb to the pressure of mobility. The pressures of fiscal security in a fluctuating modern economy demand that employees be flexible. Families often move three, four, or five times during the course of their children’s upbringing due to the changing job market. Families on the move look for investment in housing developments that will appeal to a fast turnaround resale market. Thus, communities develop with a homogenized appeal, one that resembles familiarity with past associations from other communities. Although people prefer communities that retain a local historic and natural landscape (Kaplan, Kaplan, & Ryan, 1998), families have very little time to explore additional levels of commitment when engrossed with adjustments created from mobility. Adults report an immense sense of gratification from community service, but the pressure to “stay alive financially” causes the abandonment of “community commitments in spite of their deep meaning” (Bellah, et al., 1996, p. 197).

The abandonment of the deep and gratifying values that contribute to the human rights depend on the individual's responsibility to exercise and protect these rights. It would be unrealistic to believe that today's world could proceed without turbulence, as the energy of values and morals, which have never met in the past, are confronted on a global scale (Campbell, 1993). And, in spite of the spoils created by technology, humans achieved the capacity to look outside of themselves when they entered into the celestial community of space travel and looked at the wholeness of Earth as a living, vibrant body. Man is no longer a " 'Heaven-sent stranger. ... you didn't come into this world at all. You came out of it, in just the same way a leaf come out of a tree or a baby from a womb' " (Campbell, 1993, p. 245). It is this sense of rootedness that must connect the actions of humans, beginning with community, in future decisions of governance of global policy.

Community component six: communication. Global policies and actions are dependent on the process of communication across the globe. In the past, humans measured time by astronomical observance marked by the seasonal rotation of the Earth and celestial changes of stars. Today, time is measured in atomic particles and read from atomic clocks. As seconds have become nanoseconds, the global communications systems are now peppered across the planet (Gleick, 2000). As our technological innovations continue to split the atoms of time, effective strategies for building global consensus should consider the human biological implications.

People communicate primarily with acoustic and visual signals although tactile and olfactory signals play an important part in more intimate settings (Eibl-Eibesfeldt, 1989). Languages evolved in all human societies the same, as "complex computational

systems employing the same basic kinds of rules and representations” (451). Studies on human development indicate that the rise of language led to the birth of civilization. In comparing human social behavior with the close kin of other primates, language seemed to have replaced social grooming as an adaptive way to gel bonds of security and trust (Dunbar, Knight, & Power, 1999).

Security and trust are elemental for survival in relationships of kin and group behavior in animal groups. In fact, bonds of security and trust are a major part of activity for primates in the course of a day. The expenditure of energy by living organisms is carefully constructed toward conservation in the daily encounters of survival. As humans expanded their tribes, language evolved as an activity of trust. This helped humans conserve energy toward essential daily activities such as food gathering, and enabled humans to expand their range (Axelrod & Hamilton, 1981; Barkow, Cosmides, & Tooby, 1992).

Language became the system that humans developed to detect “cheaters” in the system of trust. When John Maynard Smith (1992) developed mathematical models for economics, he applied the same principles to human behavior that led to testable predictions about the evolution of behavior, sex, genetics, and growth of life and history patterns. Environmental stable strategies could be shown revealing that the best thing for plants and animals to do depends upon what others do. Long-range experiments show that cooperative behaviors are the winners. Short-term strategies reveal that cheaters can be successful. Language for humans evolved as a system of gossip to detect the “cheaters” (Dunbar et al., 1999).

Language enables humans to create methods of learning beyond imitation, as with most other living organisms, that can be passed on from each generation to the next, creating literature, inventions, technological advances, etc. Pinker (1994) indicates that there are “universal patterns underlying the behavior of all documented human cultures” (p. 411) that can be identified. These patterns include value placed on a wide range of articulation from gossip; lying; humor; poetic speech; narrative; descriptions of weather, flora, and fauna; numbers; and kinship; just to mention a few. Differences between these patterns are reflected by the way language is influenced from the worldview of a particular culture.

Swiss linguist Ferdinand de Saussure concluded in the early 20th century that “language is a socially constructed system of signs, with no identifiable logical connection between signifiers (such as words) and signifieds (the concepts we associate with words)” essentially meaning that the logic of language is “internal and relational” (Stables, 2001, p. 122). For instance, environmental understandings are culturally variable and encoded into the root metaphors of meaning. Root metaphors that reinforce language constructions that represent “the individual as autonomous, change as linear progress, and the environment as only a ‘natural resource’ (Bowers, 1998, p. 5) begin to condition the way we think. Educators who teach ecological concepts may be so “conditioned into anti-ecological practices that the outcomes of their teaching are likely to be far from what they espouse as their aims” (Stables, 2001, p. 125). Language reflects the “cultural schemata” of a dominant culture and the root metaphors of words are encoded and reproduced in the “language of the curriculum, classroom discourse, and other areas of community and corporate life” (Bowers, 1998, p. 5).

Root metaphors that dominate modernity include emphasis on science and technology that unilaterally control the environment in an infinitely expanding frontier that is determined by economic common sense. These assumptions create “a subjectively centered individual who lacks the moral or communal grounding necessary to resist being drawn into the consumer culture” (Bowers, 1996, p. 9). This “lack of moral or communal grounding” is magnified by technologies that distance the individual from the essential to things that allow us to see through them nothing less than their being as entities. In the paradox of the dissembling of mediation, the viewer is unaware of the arrival of “remoteness,” the forgetting of what is near” (Scoggin, 2002, p. 7).

Communication theorists McLuhan and Powers (1989) warned of this disconnect of people to the ground in a type of virtual reality where reality exists in cyberspace. “Earth in the next century will have its collective consciousness lifted off the planet’s surface into a dense electronic symphony where all nationalities—if they still exist as separate entities—may live in a clutch of spontaneous synesthesia, painfully aware of the triumphs and wounds of each other” (p. 95).

H. G. Wells in 1937 described the danger of mass communication that would:

foreshadow a real intellectual unification of our race. The whole human memory can be, and probably in a short time will be, made accessible to every individual. And what is also of very great importance in this uncertain world where destruction becomes continually more frequent and unpredictable, is this, that ... it need not be concentrated in any one single place. It need not be vulnerable as a human head or a human heart is vulnerable. It can be reproduced exactly and fully, in Peru, China, Iceland, Central Africa, or wherever else ... it can have at one, the concentration of a craniate animal and the diffused vitality of an amoeba. (Gleick, 2000, pp. 254-255)

These forecasts (Gleick, 2000; McLuhan & Powers, 1989) from the past are a present reality as the world tries to cope with the human brain extended into a global

consciousness. There have been areas of advancements in global communications and relationships that benefit the whole. A global, anonymous society has opened many new possibilities for humankind including ideas of social justice, worldwide cooperation, emancipation of women, and the formation of a humanitarian consciousness expressed through the charter of the United Nations (Eibl-Ebesfeldt, 1989). Efforts to detect and treat disease and prevent the spread of pandemic infections are becoming a shared vision. Humans seem “pre-adapted to be able to live in anonymous society, and thus with many others we do not personally know” (p. 663).

The capacity to love and trust begins in the individualized group, and once this love and trust is established, individuals begin “to bond emotionally to group members unknown to us by means of identification with them. This ability, together with increasing communication”, has helped to achieve global humanitarian efforts. “But only those who have developed basic trust in the individualized group through personal ties are capable of loving others beyond their intimate circle. In other words, individualistic values and personal attachments are by no means opposed to loyalty to the greater society. They are actually the prerequisite for this.” (Eibl-Ebesfeldt, 1989, p. 663). Globalization has the ability to organize individual behavior into a massive collective that has the capacity to do more good or more harm on a scale never realized in human history. The choices and actions that individual citizens make today impact the lives of others across the globe.

Civic Membership in the Global Community

Citizenship is complicated by the increasing problems associated with the rapid changes in modern society that are affecting every fabric of community as we know it.

Citizenship is a broadly applied term because of the available access to the global network of communications that connects individuals to individuals across the globe. Citizens are tied to the local community and extended to the global via communication, economics, consumerism, etc., but most important, citizens are part of a global, ecological system that relies on cooperative partnerships for survival. Currently, human endeavors are struggling to cope with the clash of cultures and immense problems that have been created with advances in technology and the population explosion.

To define citizenship, this researcher merged educational standards from National Geographic Standards (1994) and the community characteristics taken from the Environmental Protection Agency (2002) to derive components of community knowledge that individuals should have. Because the notion of citizenship in today's world stretches citizenship from a local to global responsibility, the researcher used these two aspects of definitions to help broaden what components of community mean. Through this merger of concepts, the researcher derived six components as: (a) physical and human characteristics of place, (b) influence of culture on community, (c) local identity of place, (d) ecological characteristics of community, (e) governance, and (f) communication.

Affecting each of these six components of community is the explosion of technology that has altered landscapes, cultures, individual identity, ecology, politics, and communication to such a degree that the capacity for problem solving on a global level is immense. These different aspects of community are intricately tied to the cultural and biological advances from various fields of study, including mathematics, science, sociology, political science, archaeology, anthropology, and evolution. A global citizen

must have a broad viewpoint that includes an interdisciplinary background of various subjects.

A broad approach allows for an opportunity to view the spectrum of human accomplishments and mistakes over time. The result has been a rich and detailed description of the vital connections that humans have embodied as part of an organic and interconnected species created within and not a part from, Earth's evolution. "Our knowledge of the evolutionary process provides us with the perspectives to plan for the future; it also provides us with new responsibilities" (Eibl-Eibesfeldt, 1989, p. 650). The responsibility of global citizenship should include "the improvement of our biological construction in the sense of a 'higher development' of the unique human characteristics such as rationality, morality, conceptual ability, creative talents, and others, which is of course, a highly problematic and controversial area of discussion" (p. 650).

A part of this responsibility also accepts the concept of evolution in human development whereas competition is a "driving force" (Eibl-Eibesfeldt, 1989, p. 650). We cannot discard the competitive nature of *Homo sapiens* but we can change the direction of competition from a quantitative to a qualitative direction. Instead of fueling the appetite of gluttonous consumerism, it is time to reflect about the benefits of a life that uses quality as a goal of aspiration. The gluttony of things and choices creates a hedonistic approach where individuals become cocooned into an environment of non-tactical experiences. By choosing gluttony, the rich diversity of ecological networks will be lost. "When we lose nature as a direct experience, we lose a balance wheel, the touchstone of natural law. With or without drugs, the mind tends to float free into the dangerous zone of abstractions" (McLuhan & Powers, 1989, p. 95).

Civic education for global understanding will include knowledge that grounds human actions directly to the Earth, focusing on geography and how the environment has shaped the diversity of cultures and influenced decisions from a local to global scale (Titus, 1994). Known as the “ ‘mental disease of our times’ ”, pessimism paralyzes efforts to create change for a better world (Eibl-Eibesfeldt, 1989, p. 655). It can be used as a tool to paralyze action and create a feeling of apathy and disinterest. The involvement of individual citizens with their communities needs a revitalized effort that creates an optimistic outcome to change the course of ecological disasters. These models of optimism are needed, particularly those that can combine the interests of groups that have not previously engaged themselves toward environmental change.

Patrick Johns (1997) suggests that civic engagement requires teaching “principles and practices of democratic governance and citizenship” and contains three components: (a) civic knowledge, (b) civic skills, and (c) civic virtues (p. 10). Good models of civic education include many of the steps toward incorporation of environmental understanding, such as authentic cases of individual and group participation, as well as active engagement on local problems. Recently, as an example, representatives of almost a dozen Christian denominations in Kentucky gathered and adopted resolutions that would create broad changes in current environmental and social legislation (Smith, 2006).

One resolution called for the end of mountaintop removal. “Land ownership is being restructured, agricultural production is becoming more heavily industrialized and concentrated in fewer hands, and the earth is being subjected to harmful farming, mining, and development practices.” These situations erode the “moral and ethical values

inherent in a system of family farms, such as honesty, self-sufficiency yet interdependence, mutual trust, hard work, and neighborliness” (Smith, 2006, p. A1). Examples such as these can serve as models of action and imitation for civic engagement from a local to global level.

Civic education requires broad thinking that encompasses the various levels of resource use from a global perspective. This perspective includes the ability to understand that the actions and reactions of citizens from one part of the globe are now intricately connected and related to other citizens in other parts of the world through communication, politics, resource use, education, and religion.

In summary, this section has examined the various aspects that have contributed to the lack of citizen action toward environmental responsibility. Capitalism has fueled an endless appetite of consumption, which in turn has created cultural ideals of modernity based upon the belief that technology can always solve problems. The reliance on new technology has restructured the workforce creating a mobile society that seldom offers the comforts of a stable and supportive community. As a result, it becomes difficult for families and individuals to “know” the community in which they live, making it more difficult to become active and engaged in local problem solving and civic duty.

The following section describes specific actions and examples that educators can take to incorporate steps for environment understanding by using recommended standards from the NAAEE.

A Rubric for Four Strands of Environmental Education

Models have been developed for educators to implement as good practices for environmental education. The content determined for educators of environmental

education by those in field (NAAEE, 1999) is composed of the following four strands: (a) questioning and analysis skills; (b) knowledge of environmental processes and systems; (c) skills for understanding and addressing environmental issues; and (d) personal and civic responsibility. The four strands were developed by NAAEE (1999) in response to criticism for the lack of content and methods that are used to study and comprehend the magnitude of today's environmental crisis (Sanera & Shaw, 1999).

The strands were used to analyze Leopold's strategies for environmental education by developing a rubric, a framework that guides teachers to assess student knowledge about the content of subject matter taught (Office of Teaching & Learning, 2008), for the environmental education strands for educators can then be used to compare the strategies from Wildlife Ecology 118 to the four strands for environmental education. A rubric usually consists of four levels of achievement that range from beginning level of understanding to mastery of subject matter. Rubrics are nationally accepted tools for assessment that are recognized by all subject areas, including mathematics, science, social sciences, language arts, and environmental education. Typically, rubrics follow a basic format of a table that lists, on the left side, subject matter to be studied. Each subject is then followed by four rows of the levels of achievement: beginning, developing, accomplished and mastery (Area Education Agency 267 [AEA 267],n.d.). The rubric that the researcher devised was intended for use in college level courses; however, it has practical application to K-12 levels as well.

The following sections describe the theoretical underpinnings of each of the four strands: (a) questioning and analysis skills; (b) knowledge of processes and systems; (c) environmental problem solving; and (d) personal and civic responsibility that guide the

research questions. Each section contains a literature review of the current research and theories behind the particular strand. Following a review of each strand, the researcher organized the strands into a rubric to analyze the strategies for Wildlife Ecology 118. The rubric helps summarize the main aspects of each strand to help educators select classroom activities that will achieve environmental education practices for students at the college level. The rubric will be used to help align specific activities that Leopold used for Wildlife Ecology 118 that would match today's environmental education standards.

Strand One: Questioning and Analysis Skills

Developing environmental knowledge depends on the willingness to ask questions about the surrounding world. The nature of inquiry-oriented teaching is complex and multi-faceted, according to Flick and Dickenson (1997). Using the local community to solve environmental problems provides an avenue for understanding complex, environmental issues (Independent Commission on Environmental Education [ICEE], 1997; North American Association for Environmental Education [NAAEE, 1999]. This pedagogy not only helps to build a base for the student to study broader issues but is also shown to increase environmental stewardship (Mordock & Krasny, 2001). Investigations that require an inquiry approach involve a highly complex form of teaching (American Association for the Advancement of Science [AAAS], 2004).

Inquiry instruction means that students are given or select topics and then develop questions around those topics and use them to guide their study. The National Science Standards define inquiry "as a step beyond science as a process in which students learn skills, such as observation, inference, and experimentation" (National Research Council

[NRC], 2000, p. 104). Students, for example, can investigate the water cycle by researching how water is used in their own community. Activities would include mapping watersheds, tracing non-point source pollution to local water, and locating water source and use in their homes, etc. Researchers (Coyle, 2004; Capra, 1999; Knapp, 1996; Orr, 1992) indicate inquiry methods that use authentic community environmental problems enhance the educational experience and ground the student in stewardship.

Teachers who use the local community for inquiry teaching must constantly adjust instruction to accommodate the students as they explore and investigate problems. Materials, space, and time are elements that change as students engage in inquiry. Flick and Dickinson (1997) indicated that little research was focused on the instructional methods teachers use for this process and that most observations have focused on students and materials. In their case study of three middle school teachers and one fifth grade teacher who taught science, the researchers found the teachers' intentions were to teach inquiry but that often their instruction was explicit—that teachers would control the direction of the activity and therefore negate the effects of student-directed inquiry.

Perkins and Grotzer (2001) suggested that good inquiry methods: (a) incorporate efforts to eliminate gaps between assumption and facts, (b) compare the problem under study with other models, (c) look for misleading data and evidence, and (d) look at conflicting evidence to support a model for qualification. Flick and Dickenson (1997) furthermore, indicate there is a tension between explicit and inquiry-oriented instruction and more models like those suggested by Perkins and Grotzer are needed in instructional design for teachers.

Strand Two: Environmental Processes and Systems

Inquiry investigations in environmental education should provide more substantive content in natural science and begin the study of science with the study of the natural world (Independent Commission on Environmental Education (ICEE), 1997; National Research Council (NRC), 1996). To identify the components of the environment, students must know the local flora, fauna, and geography. Over the years, field biology courses have been replaced with studies that focus on activities at the cellular level. There is a decreased emphasis placed on the study and identification of organisms and, as a result, people tend to know more about the exotic species they view on a nature program than the animals that live in their own backyards (Pyle, 2001; Thomashow, 1995).

If teachers and students cannot recognize the animals that live in their communities, it becomes increasingly difficult to understand how food webs, cycles, and interrelationships take place. Once a species is recognized, students can begin to identify the daily patterns and cycles that are important for life support of that species. With that recognition comes the understanding that some species migrate over distances to complete their particular cycle and that several ecosystems are necessary in order for a species to survive. This global pattern is significant because it demonstrates the complexity of ecological connections and helps to reinforce the underlying principles in learning about causalities.

One of the most significant findings of the NEETF/Roper study showed that few people grasped multi-step causal relationships. Various studies (Bell-Basca, Grotzer, Donis & Shaw, 2000; Grotzer & Bell-Basca, 2001) on students and their understanding about ecosystems show that fundamental misconceptions occur based upon notions of

domain-specific causality. Students depict ecosystems as linear in cause and effect, with no reciprocity, feedback, or other means of dispersal and form. In other words, they believe there is only one way for the system to work (White, 1997).

In studying ecosystems, the student must be aware of the many different types of causalities that underlie processes. As an example, a food web shows various ways that animals depend on plants and plants on animals, as well as a passive cyclical flow of energy throughout the web. Passive flows of energy are not readily observable. Research indicates that many students do not understand unobservable events, such as energy flow and abiotic activity, or long-duration events (Munson 1994; Bell-Basca, Grotzer et al. 2000; Grotzer & Bell-Basca 2001).

Linear causalities result in simplistic one-way patterns. In this way, answers are black and white; one cause equals one effect. Domino-like cause and effects are just like they sound; one change or reaction, even if very small, can produce a whole series of events. Mutual causality is a reciprocal situation, usually a two-way pattern in which each element affects the other. Cyclic causality can involve numerous entities that are part of a cycle that continuously flows in repeated fashions (Bell-Basca et al, 2000; Grotzer & Bell-Basca, 2001; Grotzer & Perkins, 2000; Perkins & Grotzer, 2001). The lack of understanding about such cause and effect patterns results in misconceptions that result in confusion regarding ecology and how ecological models operate. The following are examples of common misconceptions when causal models are not understood by students:

1. Energy from the sun can be recycled.
2. Energy increases rather than decreases as it moves up the food chain.
3. Organisms at the top of the food chain eat *everything* that is lower on

the food chain.

4. Certain organisms should be saved from extinction, notably mammals and plants such as trees, but not organisms like jellyfish, mushrooms, or bacteria.
5. Some organisms are more important than others.
6. Photosynthesis, respiration, and feeding are not related to the recycling of matter through ecosystems.
7. Predator and prey relationships are not mutually interactive, meaning that populations are not dependent on these relationships.
8. Food and energy relationships are simplistic and linear rather than complex.
9. Genetic traits are developed as a result of a grand plan.
10. Genetic traits are passed on by bigger and stronger organisms ignoring the possibility of natural selection.
11. Populations either constantly grow or decline depending on their position in the food chain.
12. Some ecosystems have unlimited resources.
13. The disappearance of one organism has little or not effect on an ecosystem, only affecting others directly connected to the food chain.
14. Similar species have similar needs.
15. Species coexist because of compatibility (Bell-Basca et al., 2000; Grotzer & Bell-Basca, 2001; Munson, 1994).

By understanding the types of complex causal models in nature, misconceptions

can be altered. There are four dimensions of causal models that can be studied in nature: One dimension is that the underlying assumptions that rule a particular situation may not be visible. An example is the use of pesticides. The result of pest control is immediate, but the long term effects that result in genetic mutations and health problems are not visible.

A second dimension is that various causalities may be related to each other because of the patterns and effects that cause interactions to occur between and among ecosystems. In this instance, for example, there may be a loss of specific native wildflowers in Kentucky because pollinators such as the neo-tropical monarch butterfly have declined. This decline is due to loss of nesting habitats and nectar sources necessary to support the butterfly's cycle as it travels across various ecosystems.

A third dimension of causal models is based upon the results of random events that are generated by simple rules. As an example, it was once believed that birds in flocks followed a lead bird. But now it is thought that birds are merely following the actions of other birds, based on the arrangement of proximity to each other when they fly in flocks (Grotzer & Perkins, 2000).

The last dimension to understand causality requires the ability to analyze the levels and frequency of correspondence that occur from cause and effect models. This requires the ability to analyze and predict outcomes and involves higher-level thinking skills and use of inquiry (Grotzer & Perkins, 2000).

Environmental education is more than imparting knowledge about scientific facts. It must include an important understanding of the causal relationships that exist between individual action and how they can contribute to significant environmental damage. This

tendency to ignore the more indirect effects that result in a particular environmental problem is found across the age spectrum. Additionally, the farther the distance from a particular event happening, the less likely assumptions are tied with a particular event. People expect immediate results and do not want to wait for a “system’s dynamics” to play out and act.

Teaching about the various types of causalities requires a less traditional approach to instruction because these traditional approaches are not working. Studies (Morrone, Mancl & Carr, 2001), show that people reason through multi-casual steps if they are provided appropriate models. In addition, if these models are grounded in local problem solving methods, their effectiveness enhances the educational experience (Coyle, 2004).

Strand Three: Understanding and Addressing Environmental Issues

Becoming familiar with environmental problems requires an integrated approach. This approach seeks meaning by viewing patterns of relationships that evolve over a period of time. Stonier (1992) defines common sense as the ability to perceive patterns. The wisdom to perceive patterns is different from traditional ways of teaching because patterns focus on composition of matter, emphasizing form instead of quantity (Capra, 1999). In an integrated approach, one would examine the type of forest and its adaptive nature to its particular environment rather than count and identify trees.

Organizing the facts and information within patterns means looking at the level of operations in which things occur. Wilensky and Resnick (1998) concluded that patterns might occur in containments, hierarchy, or emergence. Containment patterns are more associated with mechanistic, traditional science methods. Studies are contained within fixed parameters. Hierarchal patterns are those types found in examples such as

organizational charts of governments or businesses. The president heads the country, followed by the vice president, secretary of state, etc. It is the emergent patterns that best describe the patterns of relationships or ecological strategies found in ecosystems.

Flexibility for solving environmental issues is driven by ecological strategies that share two common characteristics: They are (a) responsive to local conditions and (b) adaptive to changing conditions (Resnick, 2002). Living things and their decisions are continually adjusting and adapting to the constantly changing environment. The results of these ecological strategies occur in the various patterns and forms that make up our world. It is the way the environment functions.

The relationships established within the environment, experiences, perceptions, and realities are framed within a cultural context (Bowers, 1995). Culture is expressed through symbols such as language and reflects our values and moral behaviors (Flavell, Miller, & Miller, 1993). Theorist Uri Vygotsky (1962) believed that signs and symbols of culture influence the way we organize our thoughts. The emphasis of technology as a teaching tool in industrialized countries represents an abstract view of the real world and creates difficulties for understanding sustainable alternatives for environmental issues.

Fleer (2002) conducted a study with 486 students, ages 5 to 12, who drew or wrote what their futures would look like when they were grandparents. Overall, their drawings contained negative images of a future world that was more polluted, with a large number of drawings depicting a fully technological-oriented environment. This lack of optimism about the environment and reliance on technological advances indicates that students are not able to perceive appropriate methods for exploring solutions to environmental issues.

The reliance on technology often means that people do not connect themselves

with their environment and local environmental issues. People lack real world understanding about the overall natural processes and cannot make real world application of what they are learning (Cobern, 1988). In a quantitative study (Loughland, Reid, Walker, & Petocz, 2003), 2,000 students, ages 3 to 17, were asked to give their conceptions of the environment. The study revealed that the majority saw the environment as separate from themselves: a place that included living plants and animals but was essentially distant. Only one in eight students saw the environment in a relational aspect that supports and enhances their lives. Problem solving at the local level involves immersion into the community, but people do not connect themselves with their environment and local environmental issues. People lack real world understanding about the overall natural processes and cannot make real world application of what they are learning (Cobern, 1988).

Strand Four: Personal and Civic Responsibility

To take action on environmental issues, studies show that locus of control and attitude or beliefs are more important than knowledge for pro-environmental behavior (Hwang, Kim, & Jeng, 2000). Beliefs are influenced by two factors: (a) interaction with the environment and, (b) the interaction with other people. As people develop, they progressively move into and restructure their environments and, as environments change, environments may restructure people (Bronfenbrenner, 1996). The plasticity of both environments and people are very fluid and this plasticity underscores the vital interdependence of the ecological relationships that occur daily as well as over a person's lifetime (Hallowell, 1971; Kuo, 1967).

These ecological relationships include interactions with others. As individuals

interact with others, their beliefs and mores are formed through cultural transmission as discussed above in Section Two of this chapter (Dunbar, 1999; Eibl-Eibesfeldt, 1989; Boyd & Richardson, 1985). Culture can spread in a population through this transmission. Cultural transmission is acquired by individuals through “the imitation of others or by teaching.” This process of imitation is termed “guided variation” and occurs on three levels: (a) vertically, through parents; (b) obliquely, from mentors; and, (c) horizontally, from peers (Boyd & Richardson, 1985, p. 285).

Research on environmentally responsive behavior (ERB) supports theories of guided variation and cultural transmission. Chawla (1998) conducted interviews with selected environmentalists and found that role models and mentorship provided significant life experiences that participants indicated followed them through adulthood. Examples of activities included scouting programs, nature internships, and camping. Other research (Tanner, 1980) on environmental sensitivity and behavior appears to result from an individual’s contact at an early age with a relatively pristine environment from life experiences with role models or from negative environmental degradation.

People with pro-environment behavior possess an internal locus of control, meaning they perceive their ability to complete tasks, accept responsibility for their actions, and believe their behavior impacts the environment. Individuals with an external locus of control believe external factors are in control and individuals cannot change events. Smith-Sebasto (1995) measured the locus of control of students to determine the effectiveness of environmental studies courses for non-majors in a community college. The results for students completing the course indicated a higher measure of locus of control, a higher perception of their knowledge and skill and more frequent performance of

ERB.

Surveys conducted by Sivek and Hungerford (1989/1990) with members of environmental groups, such as Trout Unlimited, Ducks Unlimited, and the Wisconsin Trappers' Association, displayed high levels of skill in using environmental action strategies. Members of these groups participated in correlated activities that promoted environmentally responsive behavior with incentives, appeals, information, and feedback. Although more research is needed in this area to support what type of affective behavior approaches environmental educators should use (Iozzi, 1989a; 1989b), these surveys indicate the importance of longitudinal activities and peer support.

Recently, the New Environmental Paradigm Scale [NEP] (Brackney & McAndrew, 2001) was developed to measure environmental ethics. The NEP scale consists of beliefs that: (a) human health and global health are inseparable and, (b) economic growth and environmental protection must be balanced for humans to live in harmony with the ecosystem. Ninety-five undergraduate students from psychology and environmental classes were required to read five arguments about why a species should be preserved. The results from the Ecological Worldview scale derived from NEP arguments ranked morality, ethics, and importance of species to ecosystems as the most persuasive and aesthetics as the least persuasive. This study suggests that, at least with college students, critical thinking about the dynamics of ecosystems and ethical standards may be more effective in achieving a worldview that supports sustainability.

In the arena of ethical issues, there is criticism that ethical issues and cultural diversity is not addressed in traditional environmental education programs. Lewis and James (1994) created a list that needs to be considered when evaluating effective

environmental education. The list includes: (a) lack of representation of cultural diversity in major environmental organizations; (b) few examples of historic contributions from diverse cultures in environmentalism; (c) too much emphasis on environmental issues that are not relevant to people in urban settings, such as environmental injustices; (d) lack of visibility of environmental education programs in urban settings; (e) little or no representation of cultural diversity regarding planning and implementation of environmental agenda; (f) little attempt to present environmental education materials so that it reaches diverse audiences; and (g) a lack of collaborative efforts between diverse and traditional groups to improvise effective curriculums.

Most of the strategies suggested to improve action on environmental issues from diverse populations require efforts of engagement by direct contact. These strategies include attempts to set agenda, meetings, and issues so that they appeal and reach out to various populations. Additionally, examples and models of environmental action need to include a wide range of environmental issues that have broad appeal to students in various economic and cultural settings.

This broad appeal should also include the aspects of intergenerational transfer of information from students to families. A study was conducted (Vaughan, 2003) in Costa Rica to examine the effects of conservation principles on parents of children who had participated in an environmental education course on Scarlet Macaw conservation and natural history. Traditionally, environmental education programs focus on children because they represent a captive audience of future environmentalists who are “more easily taught and influenced than adults” (p. 13).

During a one-month period, students, in a rural setting, participated in a two-hour weekly curriculum on Macaw conservation and received homework assignments that required student/parent participation. Pretests and posttests were given to both student and parent groups after the course, indicating that there was a significant increase in knowledge about Macaw conservation and natural history from both groups. As students and parents participated together in homework assignments, parents began to share their knowledge, personal stories, and information about Macaws to their children.

In a longitudinal qualitative study on 5th and 6th grade students of an environmental education program that had been in place for five years, researchers (Volk & Cheak, 2003) wanted to know if the program had influenced community and family members of the participating students. The teachers of the participating students used the curriculum from the “Investigating and Evaluating Environmental Issues and Actions” [IEEIA] program. Both quantitative and qualitative data were used to measure the effectiveness of the IEEIA program on students and the surrounding community. The IEEIA program targets local environmental issues and provides students opportunities to work on authentic environmental topics and problems within the community. Quantitative results indicated increased student knowledge of ecological issues. Qualitative findings indicated that the students’ involvement in local community issues affected the “members of the community at multiple levels of involvement” (p. 23) whether or not the community members were related to the students.

The community became involved in local environmental issues as a result of the participation of students in public symposiums, reading local newspaper articles, and witnessing students change of behavior. The participation of students within their

communities became “infectious. When adults become more knowledgeable of the issues through students’ presentations, they become more than spectators. They become participants themselves” (Volk & Cheak, 2003, p. 23).

The studies of students and involvement with their community and families demonstrate the effectiveness of programs that involve direct contact with peers, mentors, and family members for influencing ERB. The other aspect of ERB includes the environmental context (Hwang, et al., 2000) cited at the beginning of this section. Using the context of natural resource-based work programs for youth ages 14-17 during summer employment, surveys were used to measure the ERB of youth before and after their involvement (Vaske & Kobrin, 2001).

The results demonstrated that as students become exposed to environmental education/work areas in natural settings, they make a “positive difference in their own community” (Vaske & Kobrin, 2001, p. 20). When people begin to make an emotional connection to the local natural resources, they become more responsible on a daily basis, which in turn creates an effective citizenry.

An interesting program (Tudor & Dvornich, 2001) that involves increased school-community links to more exposure of local natural resources is the *NatureMapping Program* initiated by the Washington Department of Fish and Wildlife [WDFW] and Washington Cooperative Research Unit Gap Analysis Project [WAGAP] in 1998. The purpose of the *NatureMapping Program* is to engage communities and schools in collecting data on wildlife for biodiversity census. This program demonstrates a top-down approach in which government initiates a program of a community-based action of ERB. It is similar to phenology record keeping, as discussed in the first section of this

chapter, because it requires participants to identify local species on a regular basis, noting:

- Observed fauna
- Habitat descriptions
- Date
- Location by state, county, township, range, section, or latitude and longitude
- Number of individuals observed, whether estimated, and how observed (i.e., saw, heard)
- Observer identification number and comments (p. 10).

NatureMapping (Naturemapping Foundation, n.d., ¶) enlists local community stewards to confirm satellite imagery that identified habitat and then Audubon members established baseline data in those areas. Communities and schools inventory the identified habitats. Participants are trained in field identification, mapping, and computers to record data. Learning about the wildlife and habitat in their community, collecting data for purposeful use and learning ecological concepts, observation, and recording skills contributed to the students' "heightened sense of stewardship" (Tudor & Donovan, 2001, p. 12). The program also captures the ideal mentoring examples that create positive learning models: "high school students mentor younger students, parents, teachers, city and land trust personnel" who participate with students in fieldwork after undergoing training in field mapping (p. 12).

The goal of the program is to create data collection modules on "terrestrial and aquatic invertebrates, freshwater fish, vegetation, soil, and climate" (Tudor & Donovan,

2001, p. 13). For environmental educators, the most important aspect of the program is that it gives students the “life skills they will need to be responsible citizens” (p 14).

NatureMapping (NatureMapping Foundation, n.d.) has expanded the program to include comprehensive modules for data collection on fish and streams.

Explanation of Rubric Criteria

The following Table 3 highlights the major points from each of the Four Strands for Environmental Education (NAAEE, 1999) and summarizes the performance standards for each strand. The format that was constructed is generally accepted from both national and state standards (AEA 267, n.d.; Office of Teaching & Learning, 2008). Table 3 shows educators how to organize activities for each strand of environmental education on progressive levels for students to achieve. This allows educators to design programs that match student performance.

Table 3

Rubric for the Four Strands of Environmental Education

Stated Objective: Questioning and Analysis Skills

Beginning Performance Standard: Students identify local environmental topics/problems in their community.

Developing Performance Standard: Students develop questions to investigate a local environmental topic or problem.

Accomplished Performance Standard: Students follow procedures such as observation, data collection, inference, and experimentation to answer questions.

Mastery Performance Standard: Students draw conclusions to help support a model for qualification to solve identified environmental problems in local community, and compare to global issues.

Stated Objective: Knowledge of environmental processes and systems

Beginning: Students must identify local flora, fauna, and geography in their community.

Developing: Students recognize the life cycles and daily patterns that support local flora and fauna.

Accomplished: Students develop connections of reciprocity and feedback among the different organisms, plants, and elements within a community.

Mastery: Students make broader applications of ecosystems on local, regional, national, and worldwide levels, recognizing that random events, fluctuating levels of correspondences, and indirect effects can cause event happenings.

Stated Objective: Skills for understanding and addressing environmental issues

Beginning: Students identify the human relationships to the environment.

Developing: Students look for patterns of relationships (including human) in the environment that have developed over time at different levels of operation.

Accomplished: Students demonstrate how organisms (including human) respond and adjust to changes in their environments.

Mastery: Students can apply cultural contexts to environmental conditions to show how organisms (including human) respond to and perceive their environments.

Stated Objective: Personal and civic responsibility

Beginning: Individuals experience contact with nature on a regular basis.

Developing: Students participate in environmental education activities with parents, peers, and mentors.

Accomplished: Students practice good citizenship of the ecological community by demonstrating acts of stewardship on a regular basis.

Mastery: Students consider daily impacts of personal decision making on the ecosystem on a personal, local, national, and global level.

The researcher created a chart based on the performance assessments outlined above that can be used for teachers to create activities based upon the assessments at various levels for students. This chart follows the recommendations from state and national implementation plans for assessments (Kentucky Dept. of Education [KDE], 2008; Office of Teaching & Learning, 2008).

As an example, for teachers interested in strengthening question and analysis skills for students in an environmental education program, the teacher would follow the progressive suggested assessments in the four levels of assessments: beginning, developing, accomplished, or mastery. To achieve a beginning knowledge, the teacher would create an activity that focused on a local environmental issue, such as air pollution. For developing knowledge, the teacher would have students' research articles that focus on sources of air pollution. For accomplished, students would connect a local source of air pollution within their community. For mastery, students would develop models to achieve ways to reduce air pollution within their communities. Table 4 may be used in a variety of ways to help teachers follow the progressive steps that build upon student knowledge to increase responsible actions for environmental improvements.

Table 4Criteria for Rubric for the Four Strands for Environmental Education

Criteria	Beginning	Developing	Accomplished	Mastery
Question & Analysis	Identify local environmental problems	Follow procedures to gather information on environmental problems	Develop questions to investigate environmental problems	Recommend models for environmental problem solving
Knowledge of Processes & Systems	Identify local flora, fauna, and geography	Recognize life cycles & patterns of living organisms	Examine connections of reciprocity & feedback between organisms in a community	Discuss broader application of ecosystem operations on various levels
Environmental Problem Solving	List ways humans are connected to natural environment	Look for patterns of human relationships to the environment over time	Compare ways organisms (including human) adapt to changes in their environments	Discuss how cultural contexts are related to environmental conditions
Personal & Civic Responsibility	Experience contact with nature on regular basis	Use environmental education activities with parents, peers, & mentors	Practice good citizenship by demonstrating acts of environmental stewardship	Evaluate daily impacts of personal decisions on the ecosystem

Continuity and Change in the Field of Environmental Education: Summary of Sections

In Section One, the researcher examined the context of the Progressive Era and its impact on the environmental movement. During the Progressive Era, U.S. technology rapidly expanded the capability of nations to extend boundaries in a global way. The

quest for natural resources to fuel the expanding advances of science and technology quickly separated cultures into the have and have nots. The advancement of science and technology also meant advances in armament such that conflicts were no longer contained within nations that bordered each other, but could be extended across oceans.

The meaning of “progress” indicated aggressive, efficient tactics that resulted in the rise of world powers. Twentieth century technology fueled an economic cycle of consumerism resulting in a destructive and deliberate attack on the ecological support systems that sustain life on earth. People abandoned their local reliance on the community and became accustomed to the ease of mass produced consumables that gave instant gratification to immediate wants. As a result, there is now a more uniform landscape, a landscape that has little identity, which is replacing the diverse and complex systems that create a balance of ecological sustainability. Within this homogenous zone, people have lost the capability to identify and recognize the plants and animals that share their local community. This loss of identity has helped to eradicate the relationships of care and nurturing that satisfy and sustain a deep understanding of human purpose.

In Section Two, the researcher examined the loss of identity people have with their community. This loss of identity has resulted in a “crisis in civic membership” (Bellah, et al., 1996, p. xvi) where people in America are entangled by the mass production of inventions that have distanced people from their neighborhoods and communities. The sense of place and regional boundaries that were once distinctive has become blurred by the increasing mobility of lifestyles where people often move many times during the course of their lives. As a result, many landscapes project a sameness of malls, subdivisions, and transportation networks, giving a false sense of familiarity to

uprooted families. These lifestyles are no longer dependent on the quality and craftsmanship of individuality, but depend on the immediate sense of comfort created by the accumulation of things rather than relationships.

The quality of individuality extends itself into native knowledge; the knowledge of the plants and animals that share the same environment as humans. People no longer recognize the special features and unique adaptive behaviors of the plants and animals within their ecological niches. This loss of recognition comes at a time when the achievements of evolutionists and ethologists have confirmed the close dependency of humans to their environments, not just in a biological way but in a cultural way as well. The rudiments of our learning and behavior resemble the behaviors of our primate cousins and the elements of learning processes can even be observed in guppies, whose brains are slightly larger than a pinhead. With this knowledge, our activities should be directed on our potential, as humans, to embellish and embrace the quality of life that can be experienced through these associations.

In Section Three, the researcher examined the specific aspects of environmental education to identify the best practices for environmental education. NAAEE (1999) has developed four strands for environmental education to help educators implement an environmentally responsible citizenry. These four strands are: (a) questioning and analysis skills; (b) knowledge of environmental processes and systems; (c) skills for understanding and addressing environmental issues; and (d) personal and civic responsibility.

Questioning and analysis skills require that students work on local community environmental problems as models for problem solving. Knowledge of environmental

processes requires a systems approach to learning that events are cyclic, patterned, and layered with feedback and loops that are interconnected. Environmental problem solving examines the cultural context of humans to their environments. Civic responsibility means that humans take responsibility to reverse the current trends of ecological destruction.

Research studies support the implementation of these four strands in the following ways: Students must use their local communities for problem solving so that they understand the democratic process of civic engagement. They must also learn the names and identity of the plants and animals that live in their environments so that they can begin to recognize the human connections with living things in a patterned, cyclic way. Last, cultural studies on human behavior strongly indicate that personal behaviors and habits are imitated through the observation of parents, peers, and mentors.

In the next chapter, the researcher describes the methods that were used to examine the various components of Leopold's Wildlife Ecology 118 class. These components were analyzed and are discussed for their potential for application in the classroom to achieve an environmentally responsible citizenry.

CHAPTER III

METHODS

The purpose of this study was to use single case historical analysis (Glesne, 1999; Merriam, 1988) in galvanizing citizen action for environmental education by examining one of the first environmental education courses developed in the United States, Wildlife Ecology 118. The researcher hypothesized that examination of one of the first environmental education courses developed by an exemplary conservationist during the Progressive Era could support and strengthen environmental education practices today by providing a heuristic perspective.

This chapter is divided into four sections. In the first section, the researcher discusses the design, historical case study. In the second section, the researcher describes the process of collecting and organizing the materials Leopold developed for his Wildlife Ecology 118 class. For section three, researcher explains how data were analyzed. Section four discusses trustworthiness for this study.

Study Design

This study used a qualitative research method that explored Leopold's teaching methods and their relationship to the context of the environmental movement during Leopold's tenure at the University of Wisconsin. The researcher used this approach to answer Research Question One [RQ1] and Research Question Two [RQ2].

RQ1: What were Leopold's learning outcomes in Wildlife Ecology 118?

RQ2: What was the context of the lessons in Wildlife Ecology 118?

A case study that focused on a general conservation course designed for “anyone” (LP, Series 6, Box 1) interested in conservation, could illuminate Leopold’s ideas about environmentally responsible behavior for citizens central to his land ethic (Merriam, 1988, p.13). In Figure 4, the researcher applied environmental history methods for analysis of the study.

Figure 4 Design of Study

This study follows the three major characteristics of case study: that it is (a) particularistic, (b) descriptive, and (c) heuristic (Merriam, 1998, pp. 30-31). This study is “particularistic” in nature because it illuminates Leopold’s teaching strategies and course content in environmental education (Merriam, 1998). The study “described” how

Leopold designed his course from personal experiences over the course of his career. The study examines these practices for their “applicability” to today’s environmental education programs.

The methods of case study are often like others in genre with the exception that historical case studies must rely on “primary document, secondary documents, and cultural and physical artifacts” (Merriam, 1988, p.8). Historic case studies must use “thick” (Geertz, 1988) description and focus on the key issues during the context of the study. Identifying “causal configurations” (Mahoney & Rueschmeyer, 2003, p. 11) during the period of study identifies broader contexts that can be applied and compared to other periods in history.

The context of Leopold’s career was focused on response of government action to individual concerns, rights, and responsibilities toward the environment. It was a time when large corporations began to influence political decision making and when globalization established its roots through technological innovations. In a comparative context, these environmental problems are still being debated today, but on a broader and deeper level (Couture, 2005; United Nations, 1998). This broader and deeper level has occurred because of the development of a global market that has fueled and satiated the individual’s thirst for consumable items. The individual’s responsibility for the environment has broadened to a global level as mass production has reached across international boundaries in exploiting natural resources and the environment.

The researcher developed a causal network in Figure 5 to illustrate how the study purpose connected to the data collection. A causal network illustrates how the factors of the case, “their interactions, and their links to key outcomes are plotted on the network”

(Miles & Huberman, 1994, p. 163).

Figure 5. Conceptual Framework for Investigating Research Questions.

The Conceptual Framework for Investigating Research Questions, Figure 5, for Wildlife Ecology 118 shows how each research question is addressed. There are two sections identified by each of the research questions. RQ1, learning outcomes, explained the types of learning outcomes Leopold employed to help his students gain understanding about the environment. These outcomes are compared to the four strands for

environmental education. The four strands for environmental education contain learning outcomes accepted in the field that are the current best practices for environmental education.

RQ2 gave the context that Leopold developed for this conservation course. Giving context to Wildlife Ecology 118 deepens our understanding of Leopold's course of action as he developed his environmental ethic and strategies to engage citizens to become environmentally sensitive. Context frames the current environmental problems into a historical perspective.

Data Collection

Historic data are "mute" evidence in that it is written text and artifacts (Denzin & Lincoln, 2000, p. 703). The interpretation of documents is "material culture" and, as such, "endures physically and thus can be separated across space and time from its author, producer, or user" (p. 703). The data collection for this study was "documents" rather than "records," meaning that documents were created for personal rather than official reasons. Documents created for personal use require a "contextualized" (p. 703) interpretation whereas: (a) meaning does not reside "in text but in the writing and reading of it" and (b) different types of text have to be "understood in the contexts of their conditions of production and reading" (p. 704). The historic data collected for both questions consisted of archival documents, photographs, and publications. The next two sections explain how data were collected for each of the questions.

Data Collection for RQ1

To identify learning outcomes, the researcher looked for data from course notes, outlines, handouts, and teaching aids from Wildlife Ecology 118. In particular, three

volumes of notes from Wildlife Ecology 118 were collected and analyzed by the researcher over the nine year period that Leopold taught the course. One volume contained Leopold's original notes and were designated as the B series. There are 258 pages of notes in the B volume. Another volume contains the notes used by Leopold's successor, Joseph Hickey, and are designated as the A series with 126 pages. Hickey's notes were often direct copies of Leopold's with some updated changes. Hickey attempted replicate Leopold's lectures and methods, even using the lantern slide projector with Leopold's lantern slides through the end of Hickey's tenure with the course (Temple correspondence, 11/12/02).

Leopold used photographs and lantern slides as a part of his teaching presentations. The black and white photographs were matched to lecture materials when possible. There are 932 photographs that the researcher copied and placed in a notebook. Some of these photographs were taken by Leopold; others were produced by some of his graduate students or colleagues, and there are many that were taken after Leopold's death. The researcher used a 35mm camera to record images. Additionally, the University of Wisconsin Dept. of Game Management provided the researcher a digitized copy of the photographs. The slides are lantern slides on glass. These images are very fragile and were not recorded. The material needed to be professionally reproduced for further studies.

The last volume of notes is those from one of Leopold's students, Lawrence Monthey, who attended the course. It is designated as the M series. This volume consists of 168 pages. Monthey was one of the students enrolled in the first Wildlife Ecology 118 class conducted by Leopold in the spring of 1939 (Monthey Papers, 1938-39). After

perusing all the data the researcher selected 32 data sources most of which were in the B series which were Leopold's original notes. Because all of these notes were not in order, and had been mixed up in various folders throughout the years that Leopold taught Wildlife Ecology 118, organization of the lectures became a challenge. The researcher used the other data from the A Series and Monthey Series, for comparison and contrast, as the researcher organized the notes as close as possible, to their original order. The researcher relied upon a symposium (McCabe, 1987) conducted in 1987 of Leopold's former students and secretaries for factors regarding field trips. These descriptions help to clarify how field trips were conducted and the activities that were included.

As notes for Wildlife Ecology 118 were collected, the course organization fell into the following categories:

1. Course syllabus
2. Recommended literature
3. Lecture outlines
4. Lectures and slide presentations
4. Case scenarios
5. Case biographies
6. Slide presentations
7. Test questions
8. Diagrams and charts

Data Collection for RQ2

RQ2 analyzed Wildlife Ecology 118 for themes found in the course curriculum and provided the contexts that identified the underlying social and political structure.

These contexts were researched by looking through other archival materials as well as using the work from *A Sand County Almanac* (1949/1970), *Game Management* (1933/1986), Meine (1988) and McCabe (1987; 1988).

The archival data, photographs, and publications generally fell into five types: (a) presentations, (b) class notes/academic presentations and lectures, (c) photographs and charts, (d) correspondence and, (e) research/publications. The data were organized into these types in Table 5.

Table 5**Data Collected for Study**

Presentations	Class Notes/Academic Presentation & Lectures	Photographs and Charts	Correspondence/ Other materials	Research/ Publications
Kulmein Club	Wildlife Mgt. 179	Land Use Practices	UW Dept Business	Phenology Record for Sauk/Dane Co.
Rotary Club	Wildlife Ecology 118	Wildlife Habitat	Curriculum for Madison Co. Schools	A Sand County Almanac
Friends/ Native Landscape	Farmer's Short Course	Research Projects	Boyhood Journals	Game Management
Green Lake	161 Wildlife Techniques	Wildlife Study: Birds	Hickey Notes	Graphs & Charts
Getaways	Orientation for Engineers	Wildlife Study: Mammals	Garden Plans	
Conservation League	Phi Sigma	Ethics/Game mgt.	Fogg Corres. on Phenology	
University of Chicago	Seminar Series	Wildlife Study: Plants	Science Inquiry Papers	
Extension Service	Symposium on Wildlife Mgt.	Hunting Trips/Excursions	Wildlife 118 Correspondence	
Young Ag Club	Taylor-Hibbard Wildlife Conf	Bird Song Studies	Rosters & Grades	
S.A.F.	Mid-West Game Conf	Ecological Matrixes	Monthey Lecture Notes	
ASCE	Phi Kappa Phi		Shack Journals	
Garden Club	Phi Sigma		Phenology in Pocket w/died & Obituary	
Dane Co. Sportsmen			Personal journal favorite quotes	

Notes and rough drafts of *A Sand County Almanac* were copied. Other materials collected included notes that Leopold began in 1935 when he purchased his farm that later became known as "The Shack." The "Shack" notes were sources for activities

ranging from course materials, *A Sand County Almanac*, *Game Management*, and scientific journals. These data were connected to context to give perspective to the relevance of examples that Leopold used for Wildlife Ecology 118.

Figure 6 showed how the researched derived the context of Wildlife Ecology 118. The contexts collapsed into four general categories: Recreational/Leisure, Research/Work related, Professional Development and Public Service.

Figure 6. Context of Wildlife Ecology 118 Materials

Analyses of Data

The researcher used comparative historical analysis (Mahoney & Rueschemeyer, 2003) to answer RQ1 and environmental history methods to answer RQ2. The following sections describe in detail how each question was addressed.

Analysis of RQ1

The basic purpose of social science research is to produce cumulative knowledge about the world. Accumulation occurs when the generation of new knowledge is gained from previously obtained knowledge (Mahoney & Rueschmeyer, 2003, p. 133). The accumulation of knowledge is facilitated when scholars classify existing information using well-specified concepts, typologies, and quantitative indexes. Causal process, methodology, and meta-theory are essential processes for obtaining social science knowledge and developing comparative analysis research (Denzin & Lincoln, 2003; Glesne, 1998; Mahoney & Rueschmeyer, 2003; Rossman & Rallis, 2003; Strauss & Corbin, 1998).

For the analysis of RQ1, the researcher followed the traditions and features of comparative historical analysis. A comparative historical analysis has three features: (a) it is fundamentally concerned with works that locate causes of important outcomes; (b) it considers the effects of the timing of events and their relation to one another and; (c) it uses a small number of cases to move back and forth between current theory and history to exemplify the subjects at hand (Mahoney & Ryeschemeyer, 2003).

The analysis of RQ1 focused on learning outcomes that Leopold selected to teach his conservation course, Wildlife Ecology 118. The researcher selected samples of

Wildlife Ecology 118 that best represent Leopold's learning outcomes. Categories included: reconstruction of a slide presentation from the photograph archives; selected lectures; diagrams that show successive histories of a particular geographic area; samples of Leopold's use of data to create environmental "texts," such as animal biographies and phenology stories; use of field trips to create student engagement with their environments; and examples of mentor/student relationships.

Analyzing Leopold's environmental education strategies frame Leopold's course of action to achieve environmentally responsible behavior. The examples selected were used for analysis against the rubric that was created by the researcher from the Four Strands for Environmental Education to clarify Leopold's meaning about how to "read the landscape" and as a way to illuminate environmental education practices over the years. Using the case of Wildlife Ecology 118, the researcher moved back and forth between the historic case of Wildlife Ecology 118 and its application to the current theory for teaching environmental education suggested in the Four Strands for Environmental Education. The analysis took into consideration the timing and effects of the events that generate the necessity of citizen action for environmentally responsible behavior in both past and current situations.

Analysis of RQ2

The intention of Wildlife Ecology 118 was, in Leopold's own words, to "develop the ability to read the landscape, (i.e., to discern and interpret ecological forces in terms of land-use history and conservation)" (Monthey Papers, 1938/39). "Reading the landscape" required an ecological interpretation or environmental history of the events that shaped Leopold's desire to develop environmental education classes. The study of

environmental history is a relatively new field and remains overlooked and understudied in the traditions of comparative historical analysis (Mahoney & Ryeschemeyer, 2003). Environmental history uses the same traditions of historical analysis with one exception. Environmental historians always consider the influences of nature and natural resources in shaping the development of human history.

Environmental history connects the actions of people to their environments and is guided by the principle that human actions must be understood within a broader scope. This broader scope includes the patterns and systems of life that sustain all life on earth, and respects the individual's contributions and impacts that influence the larger systems (Black, 2003; Cronon, 1990, 1993; Cumbler, 2001; Worster, 1988, 1990, 1993). Environmental history tells the story of ecological and cultural change. These stories include "people's attitudes toward the natural world, and stories of changing biophysical alignments, altered by forces of nature and technology working together in a complicated dialectic" (Worster, 1994, p.2).

The study of environmental history combines fields that include anthropology, biology, economics, geography, and many others (Cronon, 1993). History professor Brian Black (2003) says that environmental history can help to bring the "disparate perspectives" of emotion or "the lyrical" and the scientific together, "allowing students to take from each sub-discipline and to apply interests to issues and events in the human past, possibly even with local relevance" (p. 57). It synthesizes the influence of human interaction with physical space and deepens our understanding of the cultural mores that develop from contact with the world around us. Lessons that are contained from the study of environmental history recognize that: (a) human history has a natural context,

(b) neither nature nor culture is static, (c) all environmental history is culturally constructed, and (d) historical wisdom usually comes in the form of parables, not policy recommendations or certainties (Cronin, 1993).

Environmental history must tell the past as a story of people with their environments rather than to see history as a problem to be solved. It should provide the best source for asking the questions of a “contextual field within which to frame and discipline our analogies” (Cronin, 1993, p. 17). Telling the story of environmental history, rather than seeking answers for questions, allows the student to see the consequences of humans on their environment and the complexity of relationships that occur. Nature constrains human agency, but humans are constantly shaping the natural world (Cumbler, 2001). Within this perspective, students may grasp the unpredictable circumstances that often unfold from the lack of consideration when humans use and abuse the environment.

It is the role of environmental history to ground historical knowledge to the principles of interdependency that is central to a living natural world. Models of the past can reveal successful adaptations that illustrate the various changes that can happen (Worster, 1994). For educators, the study of the history of education helps to reflect and question “a taken for granted world to critical scrutiny, something that can be accomplished more easily in a historical context than in a contemporary one” (Kliebard, 1995, p.2). Methods for an environmental history study are at a “most basic level” (Cronin, 1990, p. 1122) as it deals with human interaction with nature.

RQ2 used environmental history analysis to link Leopold’s personal experiences to the context of the environmental conditions that influenced his career. Environmental

history uses the features of comparative historical analysis but gives further distinction to the features by using levels of analysis that help to clarify the types of human interactions with nature. These three levels of analysis for environmental history are: (a) history that includes inorganic and organic aspects of nature, (b) the socioeconomic realm that deals with nature, and (c) the cultural structures that become the individual or group dialogue with nature (Worster, 1988).

These levels of analysis were used for context to connect curriculum and themes in RQ2. The photographs and diagrams Leopold used for the class can help supplement the written content to help clarify the meaning of the material evidence (Denzin & Lincoln, 2000). The text and photographs selected by Leopold for *Wildlife Ecology* 118 were the result of his firsthand experiences produced under various environmental contexts that will be linked to the levels of analysis.

Using the levels of environmental history analysis, the researcher showed how Leopold demonstrated ways that humans in modern times can still find their voice in language of ecology. He used metaphorical meanings in *A Sand County Almanac* (1949/1970) that described human relationships with their environments and other living things. It became apparent that Leopold, whose life came from the context of an expanding, technological civilization, could still achieve environmental literacy through the day to day contact with other living things. In this way, the researcher demonstrated, through an environmental history analysis of *Wildlife Ecology* 118, that citizens do not need to be overwhelmed by the enormous complexities of globalization, but simply can immerse themselves, on a regular basis, to the voices of nature as a guide to self fulfillment, purpose, and responsibility to others.

Trustworthiness of Data

As the researcher interprets the data, it is important to follow accepted protocols and these protocols must assure that data are trustworthy and can be used to extend further practices of research for others to follow. Rossman and Rallis (2001) suggest that these standards of practice must be acceptable and competent and follow ethical standards that consider the sensitivity of the topic being studied and the setting of the research. To insure trustworthiness of data, the researcher used primary sources, triangulation of data, and constant comparative analysis (Glesne, 1999).

Primary Sources

Following the standards of acceptable and competent conformity, the researcher used primary sources, using the carefully established archival protocols of preservation and care that are universal when working with historic documents. This required sensitivity to the handling of the documents and adhering to procedures that would place documents being studied back into their original filing systems. Many of these materials had never been copied on a large scale, so the archivist requested duplicate copies, one for the researcher and one for the archives. This would help in future research and preserve the original documents so that they would not be over-handled or misplaced. The conformity of standards in this study included a constant attention to the type of source and “common sense” judgment about the accuracy of sources within the context of Leopold’s career.

Triangulation of Data

In regard to the collections of materials for this study, the researcher used a “variety of practices” that ensured the triangulation of data (Glesne, 1999, p. 31). Triangulation of data is the dominating collection methods for qualitative research. The researcher used data collecting methods that included interviews, archival data, biographies, autobiographies, ethnographies, and “multiple theoretical perspectives” of a wide range of fields and researchers. A wide range of perspectives was needed to provide a historic context of understanding as well as bring together the multifaceted range of ecological relationships that began to dominate the globalization of Western civilization during the 20th century and into the 21st.

Constant Comparative Analysis

Constant comparative analysis is the “interplay between researchers and data. It is both science and art. It is science “in the sense of maintaining a certain degree of rigor, and by grounding analysis in data” (Strauss & Corbin, 1998, p. 13). It is art in that it calls for researchers to be creative in their categories, questions, and displays, and then to devise a scheme for organizing the raw data. There are two types of comparative analysis (Denzin & Lincoln, 2003; Strauss & Corbin, 1998). The first compares incident to incident or object to object, looking for similarities and differences. The second type of analysis compares categories to similar or different concepts in order to show possible properties and dimensions. Both of these types can be broken down by using techniques (Strauss & Corbin (1998) as Flip-Flop, Systematic Comparison, and Waving the Red Flag, which are each elaborated upon in the next paragraphs.

Flip-Flop technique refers to obtaining a different perspective when analyzing an event. For example, Leopold was passionate about many aspects of issues concerning the

establishment of an academic field of game management, including the management of wildlife populations such as deer. However there were strong criticisms by colleagues and the general public concerning some of these issues. Another perspective for analysis was Leopold's biocentric philosophy, which is still the subject of debate in government, as well as religion and other ethical issues.

Systematic Comparison refers to comparing data to "one recalled from experience or literature" by looking at how often concepts emerge from the data and what it may look like under varying conditions (Strauss & Corbin, 1998, p. 95). In such an example, the researcher gained insight to Leopold's use of particular concepts and how often they emerged, giving some weight to the idea of how and why Leopold may have thought it was more important than other concepts he could have used.

Waving the Red Flag refers to the bias researchers bring with them with analyzing data and how "biases, beliefs, and assumptions" may affect the data and outcome of the research (Strauss & Corbin, 1998, p. 97). One of the ways to help track these biases is for the researcher to keep a journal of the research experience so reflection and criticisms can be compared during the course of the study.

Dimensionalizing, axial coding, and conditional matrixes are all procedures that enhance comparative analysis and allow the researcher to develop more complex and precise findings. The concept of dimensions within categories helps researchers to establish complexity beyond meaning for one particular property or phenomenon (Denin & Lincoln, 2003; Strauss & Corbin, 1998). Researchers are often encouraged to develop a continuum that can help divide properties into dimensions that the researcher found particularly useful in analyzing events during Leopold's teaching career. These include

conditions that give rise to the category, its context, the social interactions through which it is handled, and its consequences.

Axial coding enhances dimensionalizing by identifying a central phenomenon and exploring causal conditions. The researcher used axial coding to highlight Leopold's teaching strategies and identify "the context and intervening conditions" that influenced those strategies (Creswell, 1998, p. 57). Strauss & Corbin (1998) suggest a conditional matrix, an analytic diagram that maps the range of conditions and consequences related to a phenomenon or category. They describe this matrix as a series of circles in which the outer rings represent those conditions most distant from actions and interactions and the inner rings represent those closest to actions and interactions. Early in the study the researcher diagrammed a series of circles to help identify the various contexts and their connections to Leopold's life and the relationship of those contexts to Wildlife Ecology 118.

CHAPTER IV

RESULTS

The purpose of this study was to amplify the successful conservation practices of Aldo Leopold that he developed for Wildlife Ecology 118, the first conservation education course in the United States. Data for this historical analysis consisted of primary sources taken from the archives at the University of Wisconsin-Madison.

Chapter Four is divided into two main sections; each section represents one of the two research questions for this study. RQ1 examined the lessons that Leopold taught in Wildlife Ecology 118 and compared them to the Four Strands in Environmental Education. The researcher collected several hundred pages of data in the archival materials that were grouped into folders designated as Wildlife Ecology 118. Often Wildlife Ecology 118 was typed in the right hand upper corner of the paper. The archival data were not in order of the lessons taught. It appeared that Leopold kept all of his notes and made various changes throughout the years that Wildlife Ecology 118 was taught. This meant that many of the lessons were not in any type of sequence so the researcher compared several data sources drawn from course outlines in the archives that represented in the aggregate a wide range of years. When there were data that did not seem to fit in any particular order, the researcher used the Course Outline from 1947

(because it was the most recent from Leopold's instruction) to help structure the course content and sequence. The notations and marks that appear in the lessons for Wildlife Ecology 118 are from Leopold.

From these data the researcher selected 32 data points for analysis to be compared to the Four Strands in Environmental Education constructed in Chapter Two: (a) Question & Analysis [QA], (b) Knowledge of Processes & Systems [KPS], (c) Environmental Problem Solving [EPS] and, (d) Personal & Civic Responsibility [PCR].

Next, the researcher coded each datum with the learner "developmental level": Level 1=Beginning, Level 2=Developing, Level 3=Accomplished and Level 4=Mastery. For example, if datum matched Environmental Problem Solving on the Mastery level, then it would be designated EPS-4. After the 32 data sources were analyzed and compared to the Four Strands for Environmental Education, the researcher developed a chart to display all the data.

The purpose of RQ2 was to contextualize historically the lessons that Leopold selected to teach for Wildlife Ecology 118 into four subsections: recreational/leisure, research/work related, professional development, and public service. The researcher derived the four subsections based on the type of data that were collected. These data types are displayed in Chapter Three (See Table 5, Data Collected for Study, p. 124.) The researcher perused all the boxes in the archives designated as the Leopold collection and copied those data that seemed related to the time frame of Leopold's tenure at the University of Wisconsin. The exceptions included examples, but not complete files, of diaries, journals and notes from boyhood up to Leopold's tenure.

The researcher also used primary and secondary resources to further describe the various contexts of the data collected for RQ2. Meine's (1988) biography of Leopold and one of Leopold's graduate student's, Robert McCabe (1987; 1988), were the most helpful for context. The researcher visited most of the areas in Wisconsin where Leopold worked. This provided clarity for the researcher in establishing a geographic sense of proximity for field trips and research that was part of Wildlife Ecology 118. The analysis of the two research questions now follows.

RQ1: What were Leopold's learning outcomes in Wildlife Ecology 118?

The researcher used the matrix for analysis for the Four Strands for Environmental Education that was constructed in Chapter Two to compare to the 32 data points in Wildlife Ecology 118. The 32 data points for analysis for Wildlife Ecology 118 consist of: course introduction and outline followed by sections on phenology; case histories; animal biographies; wildlife techniques; dynamics of ecosystems and comparison of ecosystems on a broader level. There are 84 figures that have been scanned and matched to the 32 data sources. The researcher introduced each data followed by the related figures and then discussed their relationship to the Four Strands for Environmental Education.

Data Source One: Course Introduction: Figure 7

There are several sets of course introductions, representing different years, in the manuscript. In these introductions Leopold set the tone of the course with definitions and course requirements (see Figure 7).

INTRODUCTION

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Wildlife is here taken to mean wild mammals and birds. Although game species will be given particular attention in this course, we hope you will continually think of other animals that live under similar conditions.

Ecology is the study of life in relation to its environment. Environment is here taken as an all-inclusive term covering all external conditions and life that affects the individual animal directly or indirectly.

In covering so large a field, the scope of this course can only be introductory. By showing you how each component of the environment acts (or is thought to act) on wildlife populations, we have these objectives:

- (1) to train you to put your sciences together for outdoor use;
- (2) to show you how to read landscape and observe plants and animals;
- (3) to help you get more satisfaction out of living; and
- (4) to help you think through the "wherefores" of conservation.

Parts of the Course

1. Lectures. Avoid taking full notes; this is not a memory course. Abstracts of the important parts of the lectures will be handed out to you.
2. Reading. Required reading includes only representative samples of the best literature. Read one item each week and you will avoid futile last-minute trips to campus libraries when your tardy colleagues are trying to catch up for a quiz. The 3 scarce copies will presumably be Marks, Lack, and Hochbaum. Give them priority when they are available.
3. Projects. Select one to broaden your experience (a zoological subject, if you are an experienced botanist, and so on). No elaborate written report will be required, but in a subsequent interview you will be asked for a summary (table or graph) of your observations. (See exams below.) Inexperienced students should take No. 1. Consult with Mr. Leopold or Mr. Hickey in February if you need advice in making a selection.
4. Field trips. It is not necessary to go on all, especially if conflicts appear with other courses. (Advanced students will be drafted as squad leaders).
5. Quizzes. The two kinds will always be distinguished:
 - (a) Graded. On reading; 3 during the semester.
 - (b) Ungraded. Often ones you never encountered. Mental whetstones.
6. Exams.
 - (a) Verbal quiz by appointment on project only.
 - (b) Written final exams on lectures and reading.

Figure 7. Wildlife Ecology Course Introduction 1948

The four objectives for the course aligned with the Four Strands for Environmental Education in the following ways. Course Objective 1 matched Developing (QA2), Question & Analysis (QA2), because Leopold would “train” students to put sciences together, implying that students would become familiar with basic modes of inductive skills. Course Objective 1, “train you to put sciences together for outdoor use”, encouraged the student to understand the processes and systems that comprise the environment which matched Strand 2, Knowledge of Processes & Systems, Developing (KPS2). Environmental education began with the ability to synthesize knowledge across the natural and social sciences. Course Objective 1 also reached into Environmental Problem Solving, Mastery (EPS4), because it related to ways that cultural contexts must be considered with scientific principles “for outdoor use.”

Course Objective 2, “read landscape and observe plants and animals” matched Strands One & Two. Leopold was going “to show you” how to “read the landscape and observe plants and animals.” This indicated skills that Leopold would teach to the students for the basic modes of inquiry needed under Strand One, Question & Analysis, Beginning (QA1) and Accomplished (QA2). Course Objective 2 also encompassed Strand Two, Knowledge of Processes & Systems, Developing (KPS2), Accomplished (KPS3) and Mastery (KPS4), because it implied that students would learn skills necessary to identify, recognize, evaluate and discuss ecosystems operating on various levels.

Course Objective 3, “help you get more out of living” informed the students that their participation in Wildlife Ecology 118 would change their perception of “place” in

the world. Students would have contact with the living world on a regular basis. That ecological contact influenced students in their personal decisions to become environmentally responsible which is the goal of Strand Four, Beginning (PCR1) and Mastery (PCR4), for Environmental Education.

Course Objective 4, “help you think through the ‘wherefores’ of conservation” indicated that Leopold would demonstrate ways that students could evaluate conservation issues. This would encompass the steps that are indicated for environmental problem solving for Strand Three, Mastery (EPS4), for Environmental Education that connects cultural contexts to environmental conditions. Leopold thought conservation issues were culturally derived so students must be able to connect cultural contexts to the environment. In summary, the Objectives for Wildlife Ecology 118 match the broad requirements for content knowledge and basic skills required for environmentally responsible behavior in the Four Strands for Environmental Education.

In the next section below, of the course introduction, Leopold stated the “Parts of the Course” and gave students a wide range of choices in class participation. These activities clarify how Leopold would apply his teaching methods to achieve the Course Objectives: lectures, field trips, student projects, reading assignments, open-ended response exams and more traditional, written final exams.

Data Source 2: Suggestions for Projects, Figure 8

Suggestions for Projects provided a list of activities that ranged from a novice to advanced level of skill and required students to spend a large amount of outdoor field time in gathering information for the project’s completion (Figure 8).

Suggestions for Projects
Wildlife Ecology 118
1947

(7:30-12:30) Project Interview (2:30-5:00)

4/23	5/2 PM
4/24 PM	5/3 AM
4/25	5/5 PM
4/30	5/7 AM

Each student will select a project. At the end of the semester, he will show me a summary of his findings and a bibliography of his readings on the subject. There will be a verbal quiz on both.

5/16
5/17 AM

Students may work in pairs if the subject matter demands.

1. General Phenology. Record the date of beginning of seasonal events such as the first song in resident birds, first arrival of migratory birds, first emergence of hibernating mammals, reptiles, and amphibians, breaking of ice in lakes, first bloom of plants, and beginning of agricultural operations such as plowing and seeding of specified crops. Distinguish by asterisk between your own observations and those contributed by others.

2. Birdsong and Light. Record the time of first daybreak song or call of some common bird such as English Sparrow, starling, cardinal, bluejay or robin. Plot as a curve in comparison with sunrise. Record the weather. Deduce effect of light and weather on time of first song or call.

B14

3. Cardinal Territory. Record each day whether or not song occurs on a specified territory. Map the song perches and try to define the boundaries of the territory in relation to others of the same species. Find and date the nest if possible.

4. Chickadee Mobility. Five chickadees banded red on right foot and two banded green on the left foot are using the feeding tray at the Wildlife Office, 424 University Farm House. Map their home range during the remainder of the winter. Find if they travel as a group, and whether they tolerate other groups within the home range. Find when the group breaks up into pairs, and whether they pair with outside birds. Try to locate nesting territories. (Binoculars needed for this project.)

5. Browse Palatability List. What woody plants are browsed by cottontail? Not browsed? Apparent order of preference? Response of plants: does it resprout? Does browsing change its distribution or abundance? Parts eaten? (bark, buds, twigs.) Size limit of stems browsed? When does browsing cease?

6. Phenology of a Plant Species. Select some plant which blooms before May and in which individuals are recognizable. Mark a suitable number of individuals, and record date of first bloom in each. Distribute your sample individuals so that the resulting frequency curve will show either (a) the time-distribution of first blooms on a given site, or (b) the time-distribution of first blooms on a wide variety of sites. In a few species a comparison of (a) and (b) is possible.

7. Roost Study. Census the population of some gregarious roost such as crow, starling, or English sparrow. Trace the decline of the roost and the behavior of its members as the breeding season approaches.

8. Phenology of a Hibernator. Make daily observations on emergence of some ~~selected~~ selected hibernator in specified locations. Find out whether emergence, once it starts, is daily or not, and at what time of day it occurs. Deduce whether emergence is governed by current temperature, light, or some other factor.

Figure 8. Suggestions for Projects

The data from this sample matched rubrics that relied heavily on skills needed in Question and Analysis and Knowledge of Processes and Systems.

In these eight projects students learned skills of identification of species as well as application of those skills that showed how ecosystems operated on various levels. This matched Beginning (QA1) and Developing (QA2) levels for Question and Analysis. Leopold also asked for deductions in some of the projects that required students to summarize the interaction of humans with nature (see Project No. 1). In this case the project included cultural contexts, such as agriculture, and its relationship to environmental conditions. This matched Beginning (KPS1), Developing (KPS2) and Accomplished (KPS3) for Knowledge of Processes and Systems.

Data Source 3: Lecture Outline and Schedule, Figure 9

There were four different lecture outlines in the data, two of which had specific dates, 1946 and 1947, and two with no dates. These outlines were typed as hand-outs for students. Included with the outlines were handwritten schedules by Leopold with specific dates, 1943 and 1944, that lectures were to be given. The researcher selected data for 1947 because they corresponded with the year as Data Sample 2.

Lecture Outline
Wildlife Ecology 118
1947

(A) Plants, Animals, Soils, and Land-Use

1. History of a large area: southwest Wisconsin.
2. ~~History of a small area: a roadside fence-row 1920-1940.~~ *Habitat & birds*
3. Plant Succession, flora, and fauna: habitat.
4. Key Plants, Key Formations, Food Habits.
5. Reading Landscape.
6. Test on Readings.

(B) Population Behavior, General

7. Biographies of population units.
8. Annual Behavior, Territory, Home Range, Social Organization, Intolerance.
9. Movements: local, migratory, irruptive.
10. Distribution: spread and shrinkage.
11. Fluctuation. Cycles, irruptions, extinctions.
12. Test on Readings.

(C) Wisconsin Ecological Studies

13. Deer.
14. Bobwhite and Pheasant.
15. Rabbits, Hares, and Grouse.
16. Songbirds Studies.
17. Phenology.

Population mechanisms

(D) Community Organization

18. Food Chains and Pyramids.
19. Stability of Communities. Pest Behavior. Exotics. Equilibria. 4/29
20. Ecology and Conservation. 5/1
21. Test on Readings.

(E) Regional Ecology

22. The Canadian Prairies.
23. Chihuahua, Arizona, New Mexico.
24. Central Europe.

Figure 9. Lecture Outline 1947

Divided into five major course themes, the lecture outline encompasses all Four Strands for Environmental Education. Students became familiar with procedures and questions that lead to investigations of ways to read landscapes, to analyze wildlife population cycles and distributions, and to develop models of community organization. This matched all four levels of criteria for Question and Analysis (QA1),(QA2), (QA3), (QA4).

Leopold placed emphasis on ecological studies of specific organisms and used phenology to connect species with their environments. The ecological emphasis matched beginning (KPS1) and developing (KPS2) levels for Knowledge of Processes and Systems. Students were introduced to local as well as international cultural contexts and environments as Leopold selected specific examples from Europe, New Mexico and Canada. This matched Accomplished (EPS3) and Mastery (EPS4) level under Environmental Problem Solving. Using plant and animal identification keys and phenology examples in the lecture outline suggested that students be in contact with nature on a regular basis which is the Beginning (PCR1) level for the Personal and Civic Responsibility Strand.

Data Source 4: Lecture #1 "Putting the Sciences Together"

The introduction lecture contained several important aspects of putting together a story that crossed disciplinary subjects (See Figure 10).

PUTTING THE SCIENCES TOGETHER

In the classroom, the sciences are assumed to be separate. This is convenient for professors, who have a hard enough time explaining even one science, but it doesn't help much in the field, where you invariably have to put sciences together to explain even the simplest event.

For example: this morning at 7:26, at a temperature of -2° , a cardinal burst briefly into song at Kendall and Allen Sts. They sing rarely at this season; I have 5 records to date. Later they will sing daily. How do I explain?

Looking up, I see 2 males fighting, with a hen on the sidelines looking on. I infer that one of these males trespassed on the other's territory; the trespass explains the fight, and the fight explains the song. *The song means "Keep out - this is my back yard."* Why do cardinals not fight and sing in December? Because an internal endocrine change begins with the solstice on December 21, and is only now beginning to make the male "feel his oats". This endocrine change moves him to stake out a territory, to fight, and to sing. Cold, on the other hand, depresses him. He sings only when the endocrine stimulus overrides the depressive *cold*. This took place, momentarily, when his neighbor trespassed.

By March the stimulus will be so strong, and the cold so weak, that every male will sing every day. By May *cardinals* ~~he~~ will mate and nest.

Here I have put together physiology, meteorology, and ornithology in the form of an hypothesis. To formulate hypotheses about wildlife, and to test them for conformity to observed facts, is wildlife ecology. *a person is an ecologist - he is skillful in seeing facts, ingenious in formulating hypotheses, and ruthless in discarding them when they don't fit.*

Figure 10. Putting the Sciences Together

The sample includes all four levels (QA1), (QA2), (QA3), (QA4) of Strand One: Question and Analysis and level one for Knowledge of Processes and Systems (KPS1) using phenology as the theme that ties the aspects together. Leopold used a common, recognizable species, a cardinal, in the middle of an urban area, the university campus, to demonstrate how wildlife can be observed on a regular basis in almost any outdoor environment. In this sample Leopold defined his description of an ecologist, someone who becomes “skillful” through “seeing” to “formulate” hypothesis. The description underscores how empirical evidence relies upon scientific method and historic samples for reliability.

Data Source 5: Phenology Lecture

Leopold introduced phenology and declared that it may be more valuable “than some of my research.” He defined phenology as “a sequence of seasonal events” and proceeded with a brief history of phenology and its objectives. He used a slide program to illustrate how students could incorporate phenology for their field work and indicated that it would be a part of the field trips.

Aldo Leopold
Seminar Feb. 7, 1944

PHENOLOGY LECTURE

Definition: Sequence of seasonal events.

History: Work has been cyclic (better irruptive!) High in the 1830's;
Dean Henry 1831-32. Then declined with other "natural history";
in fact died out, save for migration phenology. Recently
revived as foundation for ecology.

Acknowledgements: Work done by Lieut. Carl Leopold and myself, for pleasure.
Now wonder if not more valuable than some of my "research".

Literature: Will review in connection with appropriate questions.

Objectives: 1. Sequence. Example: Cardinal always sings a week before
pheasant does.
2. Correlation. "Plant corn when leaves on osage orange are
as long as squirrels' ears".
3. Weather Cycles. See Trelease vs. Leopold. Summation.
Better than weather data. Cycles vs. dispersion
between years.
4. Comparing Regions, Years. New York Red Pines 10 days behind
Wisconsin in 1943. Both a week or 10 days
behind other years.
5. Seasonal Food Habits. Deer eat prickly lettuce in June.
Eat it again in August. Again in October.

Requirements: Fixed location. Periodic field trips.

I. TECHNIQUE

Slide

Feb.-Apr. Legend

Sharpness. Compare cardinal and spring peeper.

See goose record; sharp but grows in volume, hence
figures. Note zero.

What is flowering? See elm. Pollen or petals.

(821) Marsh marigold--an ideal April item (4-22-43). Conspicuous.

Birds' arrivals. Compare field sparrow and Hermit thrush.

Figure 11a. Phenology

354

- 362 What is Pheasant Crowing? Induced crowing Jan. 8, 1943. Spontaneous Jan
- 965 Prairie chicken leaves record of his "crowing". (4-12-39)
- 1142 First skunk out. A February item not here shown.
- May End of Bloom. See plum; neglected to get end. Too short, only 1 weekend
- (870) Amelanchier. Another short bloomer. Only 1 weekend.
- "Ripe" vs. "Falling". See elm and silver maple. Only "falling" is sharp.
- Birds. Oriole an ideal bird, also nighthawk, wren, whippoorwill.
- Nesting Phenology. See ruffed grouse. Only sharp dates first egg, clutch complete, hatching.
- 452 Shortear. 3 hatched, 1 unhatched. May 27, 1936.
- Tree Growth. See pines. Actual measuring sample trees. Notes no good.
- 822 Photographic phenology. Anybody want to read this?
- June-July. Struggle. See columbine.
- Growth of leaves. See basswood, hickory. Should be measured. Figures can be entered above symbol.
- Crop phenology. Rye is ripe when turns yellow. Not very sharp. See peas: only 8 days between F.B. and cut. Probably different fields.
- (929) Crop phenology. Pheasant killed by mower. 7-22-37
- (677b) Corn damage by pheasants June 2, 1937. Economic imports
- End of Song. See woodcock. Very sharp. Later will show it has only 3 day variability.
- S See bobelink. First to quit after woodcock (6/16)
- Long bloomers. See bouncing Bet. Blooms till October.
- Canada thistle. Economic importance of bloom period.
- 396 Photographic Phenology.

Figure 11b. Phenology

855

Aug.-Sept. Prairie plants. Spring (pasque, puccoon, spiderwort) & fall groups.

(1388), (1389) Puccoon and spiderwort. Early prairie plants (6/9)

(1447) New Jersey tea. Late group of prairie plants July.

(749) (750) Photographic phenology. Cutleaf silphium blooms before prairie dock. First Liatris sometime (7-23-37)

Ragweed. Hayfever charts (and sneezes) begin in July, but this is blown pollen.

Native ragweeds do not show pollen till Aug. 10.

Stubble ragweeds still later; not good for phenology.

Nut and Acorn eating by squirrels is quite sharp. In hickory hulls peel Sept. 5, 15 days later than squirrels begin eating.

When does fruiting end? Wild grape vs. elderberry.

Fall color. Need separate legend for color and falling. In poison ivy, color comes first. Will see opposite sequence later.

Fall crowing. 1943 was a late season. Nests also drowned in July. Crowing a month late. Confined to young cocks?

Bucks with clean horns. A hard item to get.

End of song. One of most difficult. Actual record shows only x marks. When they quit singing every day, rest is straggling song.

1652

Dispersion between years vs. straggle.

1093 Egrets. An August item omitted from this record.

Oct-Nov Color and falling. Plum falls before coloring begins.

Basswood colors, fades, then falls. Also sugar maple.

Elder never colors. Leaves shed upward. Tap leaves freeze off

Deer Rubbing. Easier than clean horns, because you don't need to see the deer. Precedes rut and continued through rut.

Figure 11c. Phenology

Dispersion Among Years. See mean values.

Upland plover: dispersion small. Light only?

Woodcock: dispersion large. Light plus weather?

Status of 1943: Always late.

Status of 1938: Ahead of mean: 6 years. Behind: 1 year (spiderwort)

Spring cankerworm: the "ideal" item. Tell why.

Misc. Short bloom. Only 1 weekend, like plum. Black locust same.

Short and variable. Choke cherry.

Straggle vs. bloom. More dispersion in bloom. Summer heat ends straggle?

Long and variable. Long bud period. Lilac at shack.

Straggles before, not after bloom period. Flowering spurge.

Deer eat bittersweet only when shoots young. Like elm.

(643) Earliest fall color. Dutchman's breeches turn yellow June 1.

Yearlong

Phenology Evergreens. Follow through white pine.

Fruiting shrubs and trees for food and cover improvement

Harebell. Second straggle just before frost.

Growth

of pines. Follow curves. Compare pines with cedar.

(1632) White and Red pine leaders.

Deer phenology. Physiology schedule. (Data too meagre)

(562) Horns just finished sheeding velvet.

Woody plants eaten. Arranged as a progressive series.

Herbs eaten. Double period in Veronica, triple in prickly lettuce.

Never eaten.

Other foods. Data too meagre to plot as crosses.

x x x

Figure 11d. Phenology

Excerpt from Joe Hickey's lecture notes May 24, 1943

See Chapman, p. 223

Bioclimatic Law--

Developed by Hopkins

Theory: as one goes N. E. and up on a continent opening of buds and emergence of insects will come later in spring and close earlier in fall.

4 days = 1° latitude
5° longitude
400' altitude

especially useful in seeding dates of small grains in order to escape Hessian fly in Ill., Ind., Kansas, etc.

	lat.	long.	alt.
vis. Ithaca, N. Y.	43°	77°	814'
Wooster, Ohio	41°	83°	1000'
Difference	2°	5°	186'

Correction days.

If Ithaca is May 10	-8	-5	+2	=	-11
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Wooster should be April 30.

Observed will miss it by one day over a period.

Works surprisingly well in general areas as in plains states or a continental climate. Not applicable west of Rockies or in Europe.

Figure 11e. Phenology

Wildlife Ecology 118
Aldo Leopold
(Not for publication)

Spring Phenology of Dane and Sauk Counties

Month.	Item.	1940	1941	1942	1943	Month.	Item.	1940	1941	1942	1943
January											
	Cardinal singing			1/20	4/24		Alder pollen		4/12	4/13	
	♀ picking at nest material				3/30		White pine candles start			4/25	
February							Aspen pollen		4/12		
	Pheasant crowing			1/28			Elm pollen		4/23		
March							May apples				4/25 ← in bud
	Spring peeper in voice	3/30	3/29	3/21			Field sparrow			4/12	
	Leopard frog out		3/29	5/3			White-throated sparrow			4/1	
	Snow fleas out		3/2	→	3/14		Purple martin			3/31	4/13
♀	Spring canker worm ascends	4/4	3/28	3/21	4/2		Brown thrasher		5/19		
	Woodcock peenting	3/30	4/5	5/30			Wilson snipe	4/20	4/12	4/2	
	Canada goose		3/29	3/6	3/20		winnows				
	Robin		3/23	3/7	3/14		Quail bobwhiting	4/21	5/2	4/23	
	Killdeer			3/6	3/16		Blue drosera				4/25
	Bluebird	→	3/29	→	3/14		Hepatica				4/25
	♀ Cardinal singing	→	→	→	3/20		Dutchman's breeches				(4/25) "almost" in bloom
	Lake Mendota opens all solid ice gone	→	→	→	4/2		May				
	Spermophile out			3/12			Birdfoot violet	5/12	4/30	4/25	4/25
	Yellow-bellied Sapsucker			→	4/2		White trillium	5/16	5/2	5/1	
	Common Loon			→	4/8		Anemone canadensis		5/23	5/30	
April							Spiderwort		5/23	5/30	
	Mourning cloak		4/12	→	3/26		Blue lupine		5/9	5/17	
	Butterfly (species?)			→			Columbine		5/9	5/9	
	Cabbage butterfly		4/25	4/18			Sagey sorrel	5/25	5/30	5/23	
	Ruby-crowned Kinglet				4/2		Phlox pilosa	5/26	5/23	5/23	
	Pasque flower	4/27	4/19	4/12	4/24		Phlox divaricata	5/26	5/9	5/1	
	Marsh marigold		4/27	4/22			Wild geranium	5/18		5/7	
	Hoary puccoon	5/12	4/25	5/1			Jackpine pollen			5/1	
	Wild plum			4/25			Choke cherry		5/2	5/1	
	Silver maple pollen		4/12	4/3			Wild grape		5/23	5/23	
	Hazel pollen		4/12	4/3							

Figure 11f. Phenology

Month.	Item.	1940	1941	1942	1943	Month.	Item.	1940	1941	1942	1943
	Amelanchier	5/11		4/24			White pine growth ceases			6/15	
	Nannyberry	6/1	5/18	5/23			Woodcock peenting ends		5/30	6/1	
	Wild rose		5/18	5/30			First alfalfa cut			6/15	
	Black locust		5/23	5/30			First peas cut			6/15	
	House wren		5/2	4/22							
	Crested flycatcher		5/2	5/1							
	Baltimore oriole		5/2	4/29							
	Rose-breasted grosbeak			5/1							
	Scarlet tanager			5/16							
	Indigo bunting			5/9							
	June Fireflies		5/30	6/7							
	Harebell		6/7	6/7							
	Marsh blueflag		6/7	6/5							
	Spatterdock			6/5							
	Tarrow		6/7								
	White clover		6/7	6/1							
	Fleabane		6/7	6/7							
	Quack pollen		5/30	6/15							
	Gray dogwood			6/7							
	Silky dogwood		6/7	6/7							
	Wahoo		6/7	6/7							

Desiderata in Phenology

Balance. Get a good representation of each class: birds, mammals, woody plants, herbs, insects, reptiles and amphibians, agricultural events, physical events (such as break-up of lake).

Definitive Items. Items differ greatly in (1) sharpness (2) dependability. Thus the ascent of the spring canker worm is absolutely sharp, and cannot be missed if you have tanglefoot on an infected elm. On the other hand, first bloom of dandelion is sharp, but radically affected by the warmth of the site. First bloom of apple is worthless because different varieties bloom at different times, but first bloom of one apple tree is sharp and dependable. Ripening of all fruits is hazy, but first pollen is sharp.

Beginning and Ending. In many events the ending is just as important as the beginning, but much harder to record. Most lists are deficient in endings.

Local vs. Distant Events. Arrival of birds may reflect the weather where they come from, rather than where they arrive. In this respect all resident organisms are superior for phenology.

Figure 11g. Phenology

The phenology lecture and slide program met the criteria for the four levels (KPS1), (KPS2), (KPS3), (KPS4) of Knowledge of Processes and Systems. To apply phenology, students had to identify local flora, fauna and geography (Figures 11a, 11b, 11c, & 11d) and connect the three together by identifying the patterns of reciprocity and feedback between organisms and their environments throughout the course of the seasons. Through connecting the relationships of organisms to their environment, phenology could be used to predict how organisms would respond to the seasons in other geographic locations.

Leopold used the example of planting grain crops in correlation to the emergence of the predator Hessian fly (Figure 11e). By comparing phenology records, he demonstrated how farmers could plant the seeds for their crops before the Hessian fly emerged to feed on the seeds. Using geographical vectors such as latitude, longitude and altitude, farmers in Ohio would plant their crops on April 30 and farmers in Ithaca, N. Y., would plant 11 days later. By planting the seeds before the predator Hessian fly emerged, the farmer could rely on greater germination of seeds thus a more prolific growing season. Using these examples, Leopold taught the importance of how the smallest changes in the environment could affect a specific organism. That adjustment from the organism would then affect other organisms.

Leopold supplied a sample chart of Spring Phenology of Sauk and Dane County (Figures 11f and 11g) for students so they could understand how to record, compare and contrast phenological data. The chart is a good example for students of how to follow procedures for collecting phenological data and is a Developing (QA2) criteria for

Question and Analysis because students must follow procedures to develop and interpret phenology charts.

Data Source 6: Reading the Landscape

Leopold interjected this lecture before he presented the case histories that followed. This lecture described the most important aspects of reading the landscape which was to interpret the plants that were current to make assumptions about the past. Local environmental problems could be solved by understanding past land use. Land use could be identified by the types of plants, animals and soil conditions that were currently visible.

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narrow deep creeks with trout
1870 period of wheat farming boom
quail + chicken abundant, turkey gone
wheat business came to an abrupt end in mid '70
① chinch bug
② competition of wheat growers to the west

1930: dairy farming
less timber & pasturing on slopes
creek now wide + shallow with oxbow
alfalfa now grown instead of wheat

1943 beginnings of soil conservation
contouring strips and contour plowing
logged draws
check-damming
protecting woodlots

Figure 12a. Landscape

Hickory

assignment

Prob #1 - Due Feb. 23

Field trip Sat. 8 AM 3^{PM}

Traces in ^{used} reading landscape in Wisconsin:

Often planted

elm (W)

silver-barked maple

europ. evergreens

scotch pine

norway pine

mulberry (W)

box elder (W)

arbor vitae

Seldom planted

cottonwood

hackberry

basswood

red cedar

walnut

Never planted

oaks

hickory

Hence the presence of an oak over 100 yrs old
indicates former timber

The presence of an oak under 100 years old may indicate

a) reproduction

b) encroachment

| fairly good evidence of non-grazing

Old oaks, no reproduction = { pastured woodlots;
no plowing

Jumping mouse ^{only in quantity} found ^{wherever} Carex stricta is found

Figure 12b. Landscape

Reading the Landscape (Figures 12a and 12b) fits the four levels (QA1), (QA2), (QA3), (QA4) of criteria for Question and Analysis because it describes how environmental problems can be identified through the recognition of the types of current flora and fauna that exist in a particular area. Species identification can help to develop the necessary questions to investigate and resolve environmental problems. For example, oak trees were seldom planted in the Wisconsin landscape, so their presence may indicate that past land use was for timber. Leopold used specific examples as models for indicators of environmental problem solving.

Reading the Landscape (Figure 12a) fits the four levels (KPS1), (KPS2), (KPS3), (KPS4) of criteria for Knowledge of Processes and Systems because identification of local flora, fauna and geography is part of pattern recognition that is descriptive of the connections of reciprocity and feedback. In this instance, knowledge of the environmental history is identified and thus can be applied in other situations for comparison of ecosystems (Figure 12b).

This lesson is also applicable for the criteria for Developing (EPS2) and Accomplished (EPS3) levels of Environmental Problem Solving because it connects human relationships to the environment over time. Changes in the environment occur over time from the human manipulations of the landscape.

Data Source 7: Case 1: History of a Roadside

Leopold developed scenarios that depicted various stages of succession over a period of time. He used examples that, in most cases, contained familiar and common landscapes. These cases served as historic treatises that could be used as a reference for future environmental problem solving. There were eight of these scenarios or cases that

Leopold created. All of the eight cases are presented here; however, there is evidence from Leopold's class schedule that he selected various cases to discuss over the 13 years that he taught Wildlife Ecology 118.

In this generic case, Leopold described the denuding of landscape by the introduction of a road. The road changed over time, as the technology and culture of human transportation advanced and created the necessary, structural adjustments for the different types of vehicles that were created and modified.

583

Case 1: History of Roadsides

X-98

Stage 1: 1920. This is an unimproved country road. The right-of-way is occupied by three competing groups of vegetation:

<u>Prairie Remnants</u>	<u>Oak and Hickory (brush stage)</u>	<u>Exotics</u>
Silphium	Hazel	Bluegrass
Liatris	Sumac	Sweet clover
Butterfly weed	Haw	Timothy
Andropogon	Crab	
Prairie clover	Gray dogwood	
Shooting star	Bur oak	
Wild rose	Wild plum	

The roadway is occasionally debrushed, which tends to give the upper hand to groups 1 and 3. When debrushing is neglected for three or four years, group 2 tends to shade out the others. These changes, however, are oscillations about a mean. The roadway is in equilibrium, and furnishes cover for a rich fauna which finds its food in the adjoining fields. This fauna includes:

<u>Game</u>	<u>Fur</u>	<u>Rodents</u>	<u>Songbirds</u>
Bobwhite	Skunk	Woodchuck	Meadowlark
Phoeasant	Weasel	Spermophile	Field sparrow
Cottontail		Chipmunk	Indigo bunting
		Deer mouse	Brown thrasher
		Meadow mouse	Catbird
			Vesper sparrow
			Mourning dove
			Shrike

There are 17 major plants and 18 major animals.

About 1920 the road is slightly graded for better drainage, and gravelled against wet weather. The lime leaching from the gravel increases the sweet clover in the ditches, but this has no adverse effect on either fauna or flora.

Stage 2: 1930. The road is widened to enable cars to pass, and debrushed oftener to prevent snowdrifts. The risk of drifts exists only in spots, but the whole length is nevertheless debrushed. To road crews brush is brush; they would not understand qualified instructions about debrushing.

All the prairie species except silphium are extinguished by the gradings. Silphium is able to sprout from the severed root on the new cutbank, and hence persists. The woody species are reduced by the more frequent debrushing, and by the loss of area available. The exotic species are increased by the intrusion of lack grass on the new cutbank.

Bobwhite, deer mouse, chipmunk, shrike, thrasher, and catbird go out with the brush. There are now 10 plants instead of 17, and 12 animals instead of 18.

Figure 13a. Case 1: History of Roadside

Stage 3: 1940. The roadside is now "streamlined" to permit of easy mowing, and to facilitate mowing, the roadside is burned yearly. The steep cutbank is graded down to the angle of repose, and the roadway is gravelled.

The stated object of these expensive changes is "farm-to-market" roads, but similar changes are made on blind roads and cross-cuts on which no farm depends. The real objects include the use of surplus relief labor, and the need of more mileage to qualify for more maintenance funds.

The remaining prairie and brush species are thus extinguished. The now ~~quack~~ cutbank is over-run by quack, which crowds out even its exotic competitors, bluegrass and timothy. The repeated denudation of the bank starts a gully in the drainage ditch. The bur oak, by reason of repeated defoliations by June beetles, is now dead. In its place, the landscape engineer in charge of highway beautification plants an elm.

All game and fur species are now out, for there is no cover. The rodents are out except spermophile and microtus, which increase.

The songbirds, except meadowlark and vesper sparrow, are all out.

There are now 3 major plants (quack, bluegrass and sweet clover) instead of 17. All are exotics.

There are now 4 animals instead of 18. Two of them are injurious rodents.

The roadway, instead of serving as a refuge for a rich flora and fauna, serves as a refuge for animal and plant pests.

Questions

1. Assuming that the grading and mowing and burning are necessary, what group of plants could have been used to "landscape" the unmowable shoulders?
2. On what woody plant was the shrike dependent in Stage 1?
3. Why is quack grass a hazard to farming?
4. Why do old highways following survey lines display more prairie remnants than new "relocated" highways? Why do railroad rights-of-way display more prairie remnants than highways? What do you deduce is the tolerance of prairie plants to (a) grazing, (b) burning?

Figure 13b: Case 1: History of a Roadside

Progress on the Prairie

Bobwhite
Pheasant
Meadowlark
Field sparrow
Indigo bunting
Brown thrasher
Mourning dove
Shrike
Vesper sparrow

Mammals

Skunk
Weasel
Cottontail
Woodchuck
Spermophile
Chipmunk
Deermouse
Meadowmouse

Pheasant
Meadowlark
Indigo bunting
Mourning dove
Vesper sparrow

Cottontail
Woodchuck
Spermophile
Deermouse
Meadowmouse

Meadowlark
Mourning dove

Spermophile
Meadowmouse

Figure 13c: Case 1: History of a Roadside

Case 1: History of a Roadside aligns with Beginning (QA1) Question & Analysis, by identifying local programs. It matched Beginning (KPS1) and Mastery (KPS4) Knowledge of Processes & Systems, by discussing the operation of ecosystems on various levels. It also matched Mastery (EPS4) Environmental Problem Solving because it showed how cultural contexts were related to environmental conditions. Through Stage 1, 2, and 3, students became introduced to the impact of human intervention on landscape over time when roads were introduced into natural areas.

In Stage 1, flora and fauna were mildly affected with the introduction of a country, dirt road but the impact was minimal and the remnant prairie plants were not affected. The road bed changed in Stage 2 as cars became an increasingly popular vehicle for transportation of people, goods and services. The road was debrushed for better maintenance of the increased vehicular traffic. Prairie plants became completely extinguished, except for silphium and there is a loss of 6 species of animals when the habitat was disrupted.

By Stage 3 there was a minimal amount of wildlife species left. Leopold demonstrated how cultural bias, in this case economic politics, took over ecological sense, as blanket decisions were made to “streamline” roadsides, even on roads that are used very little. Erosion and exotic species takeover and “the landscape engineer in charge of highway beautification plants an elm”. Question one (Figure 13b) required that students choose the proper plants for landscaping on unmowable shoulders. This matched the Accomplished (EPS3) Environmental Problem Solving to compare ways organisms adapt to environmental changes. Question two is Accomplished (KPS3) under Knowledge of Processes and Systems because students had to understand the relationship

of the shrike to a particular plant species, a question that required students to examine the connections of reciprocity and feedback. Question three required that students have Mastery (EPS4) in Environmental Problem Solving. How is farming, i.e., a cultural context, related to quack grass and in what way would this species affect farming practices, i.e., environmental conditions?

Question Four matched several of the Four Strands for Environmental Education. Students had to compare and evaluate how landscape was affected by old highway survey lines to the newer survey lines which would be a Mastery (PCR4) Level rubric for Personal and Civic Responsibility. They were also required to analyze the difference between cultural contexts of railroad and highway as these contexts affect prairie remnant plants which would be a Mastery (EPS4) Level rubric for Environmental Problem Solving.

Data Source 8: Case 2: History of Prairie Coulee

For this case (Figures 14a, 14b, 14c and 14d) the student was introduced to land practices that changed a former prairie into a farm (1840-1938). The scenario captured the underpinning economic pressures of change that began with the demand of the fur trade in the early development of the United States. As the supply of fur bearing animals declined, the pioneer settled into the landscape, cutting timber and clearing the land. The pioneer manipulated the soil to produce wheat and corn until a new predator, the cinch bug, destroyed the wheat fields. Pioneers opened the way for large scale farming that shifted the land use on dairy production. Erosion resulted as large areas of land are cleared and the rich, prairie soils were washed away into creeks. Flooding was more frequent and the once ecologically rich landscape was altered to monoculture practices.

Leopold, however, did not leave this scenario as an end of disaster. He produced a solution that gave fruitful and lasting hope for positive change. Government provided intervention and extended a cooperative agreement with the farmer that benefited the community.

Case 2: History of a Prairie Coulee

This terrain represents a typical farm in the unglaciated area of south-western Wisconsin. It includes a creek valley or coulee, and an adjacent prairie upland. The boundary of the prairie was determined by fire and lies at the edge of the flat upland. Two communities are included:

<u>Prairie Community</u>		<u>Mixed Hardwood Community</u>	
<u>Plants</u>	<u>Animals</u>	<u>Plants</u>	<u>Animals</u>
50 grasses, herbs, and shrubs	prairie chicken jackrabbit elk	white oak walnut basswood	wild turkey pass. pigeon ruffed grouse deer bear

Between the prairie and the mixed hardwood lies a "tension zone" sprinkled with large open-grown bur oaks. Under and between them grows an understory of hazel, plum, crab, haw, grape and sumac. The distinctive animal of this border zone is the quail, although it is used to some extent by the animals of both the adjacent communities. The bur oaks occasionally succeed in invading the upland, but in such situations the underbrush is kept down by fire and replaced by grass. Such orchard-like groves are called "oak openings."

Stage 1: 1840. The trappers who preceded the settler have cleaned out the elk. The settler has built his log cabin at the edge of a clearing on the creek bottom. He raises corn in this clearing and wheat on the prairie upland. The low land along the creek is used as hay meadow, and the hay is stacked on the creek bank. This implies infrequent floods. The creek is narrow and deep, and contains large brook trout. The settler's cattle run at large in the woods, but have as yet not substantially altered its ecology.

Stage 2: 1870. The clearing now extends half-way up the slope, thus constricting the hillside timber at its lower edge. At its upper edge, however, the cessation of prairie fires has allowed red oak to encroach to the edge of the wheat field. This red oak is even-aged and dense.

The animal life has been altered only by the elimination of deer, bear, wild turkey and passenger pigeon. These were "meat species" for the settler, and were large enough or gregarious enough to be sold.

Floods are somewhat more frequent due to the continued raising of wheat on the upland. About 1878, however, the chinch bug forced the abandonment of wheat as a commercial crop in Wisconsin.

Stage 3: 1930. The type of farming has now changed from general farming to dairying. The hillside timber has been constricted to a narrow belt which is all pastured. A silo has been erected. Floods are so frequent and severe that it is no longer possible to stack the hay on the creek bank. The channel has widened and exbowed, and is undercutting the remaining bank timber. The creek

Figure 14a. Case 2: History of a Prairie Coulee

has cut a supplementary flood channel in the pasture.

The depletion of the upland prairie soil has induced rapid run-off, which has cut a deep gully down the hillside. With each heavy rain this gully deposits rocks and debris on the creek bottom.

The flora has now been radically altered. The entire prairie flora is gone. The plow got most of it, and the encroaching oaks shaded out the remnants in the border zone. The rich forest undergrowth of the hillside is replaced by bluegrass. The valuable saw timber on the hillside consists of the even-aged red oaks which followed the cessation of prairie fires.

The fauna is likewise greatly reduced. Brook trout are replaced by brown trout, and these are incapable of natural reproduction because of the flashy character of the creek. Ruffed grouse are nearly gone, prairie chickens and woodcock are entirely gone, and the remaining quail are irruptive in their population behavior. Opossum has invaded the region from the south.

Stage 4: 1938. The farm is now signed up as part of a soil conservation project.* A check dam has been built in the gully. The creek bank has been excluded from the pasture and replanted to willows.^o The steeper parts of the hillside have been excluded from pasturing and planted to conifers. The acreage of corn and oats has been reduced and the acreage of alfalfa increased. These modifications of agronomic practice are stipulated in a contract with the government.

The only further change in the composition of the fauna is the addition of a few pheasants. No game species, however, with the exception of fox squirrels, persists in abundance.

Questions

1. What is the meaning of the term "wheat gully."
2. When a watershed begins to display floods and gullies, is the deterioration of the soil far advanced, or has it just begun?
3. When pastured woods are closed to grazing (stage 4), does the original undergrowth reappear, or do we get a new set of species? Why?
4. Was the wooded area in 1870 greater or less than in 1840?

*Leopold, Aldo. Coon Valley--an adventure in cooperative conservation. American Forests, May, 1935.

^oFry, J. R., Jr. Willows for streambank control. Soil Conservation, Vol. IV, No. 5, November, 1938, pp. 109-111, 128.

Figure 14b. Case 2: History of a Prairie Coulee

Mammals

History of a Prairie Coulee

Birds

89

Deer
Cottontail
Jackrabbit
3 squirrels
Raccoon, skunk
Otter, mink

Ruffed grouse
Pr. chicken
Quail
Wild turkey
Pass. pigeon
Woodcock

Cottontail
Jackrabbit
3 squirrels
Raccoon, skunk
Mink

Ruffed grouse
Pr. chicken
Quail
Woodcock

Cottontail
Jackrabbit
Fox squirrel
Skunk
Opossum

Quail
Ruffed grouse

Cottontail
Jackrabbit
Fox squirrel
Skunk
Opossum

Quail
Ruffed grouse
Pheasant

Figure 14c: Case 2: History of a Prairie Coulee

TREND OF VEGETATION AND ANIMALS, S. W. Wis. (Case 2)

Figure 14d. Case 2: History of a Prairie Coulee

History of a Prairie Coulee delved deep into all Four Strands of Environmental Problem Solving in the mastery levels. For Mastery level (QA4) in Question and Analysis, Leopold developed a model in which a cooperative agreement between government and farmer worked for long term, sound environmental practices (Figure 14b). For Mastery (KPS4) in Knowledge of Processes and Systems, Leopold showed how ecosystems were affected when diversity was altered such as when soil erosion and flooding occurred as hillside timber was stripped away (Figure 14b). In another example, he demonstrated the effect of monocultures and predator relationships when the cinch bug destroyed the wheat crops (Figure 14a).

For Mastery (EPS4) in Environmental Problem Solving Leopold provided examples of how the various pressures of cultures affected natural resources over time. From the trapper to the diary farmer, students were shown how the landscape was manipulated for various purposes. Last, in Mastery (PCR4) in Personal and Civic Responsibility, Leopold demonstrated how ecosystem health was influenced by the pressures of individual choice.

Question one (Figure 14b) required students to define “wheat gully” which is a Beginning (KPS1) rubric under Knowledge of Processes and Systems. Question two and three (Figure 14b) are comprehension questions because students must look at the connections of reciprocity and feedback under the Accomplished (KPS3) rubric for Knowledge of Processes and Systems. In question three students were to have knowledge of the conditions that supported various plant species, which related to the Mastery (KPS4) level of Knowledge of Processes and Systems. The last problem called

for a comparison of the wooded area over a thirty-year span which is an Accomplished (EPS3) level under Environmental Problem Solving.

Data Source 9: Case 3: History of the Ragweed Patch, Faville Grove

This sample (Figure 21a and 21b) began with a small glacial pothole in Wisconsin that consisted of a natural bog drained by a farmer. Leopold followed the succession stages of the pothole over a 100 years (Stages 1 to 3). The area that began as ecologically rich area was reduced to a monoculture and then revived to support more diverse species of plants and animals. Intervention for successful conservation practices was provided by a team of scientists and government support.

Case 3: History of the Ragweed Patch, Faville Grove *

The closed basin now called "The Ragweed Patch" is a glacial pothole of about 8 acres, filled with peat.

Stage 1: 1850. Stoughton Faville's father, during the 1830s, kept a boat in this basin for the purpose of hunting ducks. Mr. Faville remembers that it contained open water and also a "quaking bog" in which pitcher plants grew. Probably it also bore tamarack, for tamarack logs were dug up in ditching a similar bog just south of this one.

Like most potholes, the open water was probably peripheral, and the succession stages lay in concentric rings. The outside banks bordered wheat fields, and had already been reduced to grass and weed stages. The central floating bog, judging from relics persisting elsewhere, consisted of sphagnum peat supporting a flora of bog plants. In addition, the open water must have carried a rich aquatic flora.

Ducks are known to have nested, but the remainder of the fauna of 1850 is not known. It may have included prairie chicken, woodcock, jacksnipe, red-backed mouse, long-eared owl, horned owl. About 1865 a flock of six sandhill cranes stopped at the bog and fed in the field which lies to the north.

Stage 2: 1911. About 1870 the water was drained off through a ditch. This drainage proved to be imperfect so about 1911 a drain tile was substituted. The farmer burned yearly the weeds following this drainage. In dry years these fires burned into the peat, especially the deep peats of the central floating bog. The resulting ashes produced a dense jungle of giant ragweed (and in one spot, aspen). When we came on the scene in 1933 he had again burned the ragweed, which formed a monotype over the entire basin.

Thinking ragweed to be good cover (it is when mixed in small patches) we erected a feeder, but no game could be induced to winter in the ragweed patch.

The flora: Giant ragweed, with a few aspen, red dogwood, Carex, Spartina plants. The flora had been reduced from about 60 to about 6 plant species.

The fauna: Blackbirds (as a roost), meadow mouse, cottontail, skunk.

The farmer was persuaded to quit burning so that the natural processes of plant succession could variegate the vegetation.

*The known data for this area is summarized in "A Wildlife History of Faville Grove, Wisconsin," by Arthur S. Hawkins. Pending publication in Trans. Wis. Acad. of Sciences, Arts and Letters.

Figure 15a. Case 3: History of the Ragweed Patch, Faville Grove

Stage 3: 1942. (After four years of non-burning.) Most of the ragweed has been replaced by forbs (nettle, aster, goldenrod). The surviving brush, tree, and grass relics have spread, thus breaking up the ragweed monotype. B-72

The flora: These species have come in; 2 asters, 1 goldenrod, 1 bidens, 2 polygoms, 1 Thalyticrum, 1 Chelone, several grasses. Total gain about 10 major species.

The fauna: Apparently as a result of this enrichment of the flora, an increase in the number and kinds of animals has taken place. The winter censuses show:

<u>Species</u>	<u>1936</u>	<u>1937</u>	<u>1938</u>	<u>1939</u>	<u>1940</u>	<u>1941</u>
Pheasant	14	28	3	3	13	30
Hungarians	15	20	?	?	25	22
Cottontail	15	21	26	?	6-10	6-10

In addition, there are skunks, minks, weasols, and meadow mice. The former status of these mammals is unknown, but it is likely that the larger ones moved in as the changes in vegetation made room for their prey. They are also known to den in the holes burned into the peat by former fires.

Severe corn damage occurred in 1938 from blackbirds which used the area as cover. This, however, was probably also the case during stage 2.

Cottontails are now so numerous that they have destroyed four successive plantings of white spruce made on the dry edges of the peat basin.

Questions

1. Can the future stages of the plant succession in this basin be predicted?
2. By what process, and by reason of what property, do forbs replace weeds? What is the agricultural analogue of this replacement?
3. By what process, and by reason of what property, did the aspen patch originate?
4. Speculate on the reasons for the low carrying capacity of pure giant ragweed?
5. What became of the central "quaking bog" of peat which once occupied the center of this basin?

Figure 15b. Case 3: History of the Ragweed Patch, Faville Grove

This source included all Four Strands for Environmental Education. The case of Faville Grove aligned with Mastery (QA4) performance as Leopold demonstrated over a 100 years how problems were created and solved. Performance standards of all four levels (KPS1), (KPS2), (KPS3), (KPS4) in Knowledge of Processes and Systems are met because flora and fauna are identified and there are specific interrelationships that developed over time to show how ecosystems function on different levels. The ragweed patch responded created a monoculture that was difficult for other plant species to invade.

Environmental Problem Solving is addressed on Accomplished (EPS3) and Mastery (EPS4) levels, as various cultural contexts are given that began with the farmer and ended with a cooperative relationship among the farmer, scientists and government. Successful management practices yielded a return to a more diverse ecosystem that could support a variety of wildlife. Person and Civic Responsibility is included on the Mastery (PCR4) level as part of the result of personal decisions that affected the ecosystem of the glacial basin that changed during the 100 year period.

Questions 1 to 5 (Figure 21b) that Leopold developed for the students matched Knowledge of Processes and Systems and met performance objectives in all four levels(KPS1), (KPS2), (KPS3), (KPS4). The questions are very specific to the identity of species and the understanding of ecosystems, patterns, interrelationships and how operation of ecosystems occurs on various levels.

Data Source 10: Case 4: History of Central Wisconsin Marshes

For this case students were introduced to the ecological scenario of a marsh that was manipulated over 100 years as economics changed (Stages 1-4). The initial setting was an undisturbed marsh where students were familiarized with key plant, animal and

soil indicators found in a marsh setting. The deep layers of the peat bog were eventually worn down by various agricultural practices ranging from hay to cranberry production. Government intervened to re-flood the area but in this scenario Leopold left students with questions about the future potential of the area to support wildlife.

Case 4: History of Central Wisconsin Marshes

Stage 1: 1840 (before settlement)

<u>Type</u>	<u>Vegetation</u>	<u>Animals</u>
Water	Acid aquatics	Waterfowl, muskrat
Peat basins	Tamarack or Black spruce or Leatherleaf or Sedge & bluejoint	Sandhill crane Sharptail grouse Snowshoe
Sand "islands"	Oaks White pine	Sharptail grouse Deer Passenger pigeon
Edges of islands	Bog birch, alder White birch	Ruffed grouse Snowshoe
Bluffs	Oak, Norway pine	Ruffed grouse Deer

Because of the high water table, the marsh at this stage seldom if ever burned, and never deeply. The exact extent of climax spruce and tamarack is not known.

The fauna was rich in species but densities were low. There were probably no prairie chickens. Pigeons, in those years when there was no beech mast in Michigan but abundant black oak mast here, nested in great numbers.

Settlers from 1850 onward cleared some of the broader "sand islands" and the uplands adjacent to the marsh. This introduced grain and wood foods, allowed prairie chickens to invade the region. Sharptails, cranes, and deer probably increased with the enhanced food supply.

Stage 2: 1870 (after settlement)

The settlers had no alfalfa and relied on the marsh for hay. Most upland homesteads included a small "hay holding" in the marsh. To facilitate haying, the marsh was frequently burned, and shallow drainage ditches were dug by hand. The water table remained high, however, so these fires seldom burned into the peat. They did, however, greatly reduce the area of tamarack and spruce.

Later lumbering, in conjunction with fire, eliminated most of the pines from the sand "islands" and bluffs. Because of fire, much of the growing sphagnum on the surface of the peat was replaced by hay grasses: bluejoint, redtop, timothy. Prairie species invaded the pine slashings on the "islands."

Figure 16a: Case 4: History of Central Wisconsin Marshes

The general reduction of timber, increase in grass and low brush, and invasion by agricultural plants greatly increased prairie chickens at the expense of sharptails. Cranes probably increased. Snowshoes virtually disappeared and were replaced by cottontails. Quail entered the region. The prevalence of fire increased blueberries.

This haymeadow stage represented a considerable modification of the original fauna and flora, but it was a stable self-sustaining stage as far as the marsh is concerned. The light upland soils, however, failed to stand up under decades of cultivation. Crop land began to gravitate toward the marsh.

Stage 3: 1890. Drainage and fire.

The general land boom and the availability of steam dredges brought about a wholesale drainage of the marsh, which was divided into farms and sold to settlers at high prices. During the ensuing 20 years these farmers gradually succumbed to unseasonable frosts, high drainage taxes, and loss of peat soils by fire. As the farmers moved out, every drouth brought more and deeper peat fires, culminating in the great fire of 1930.

After a peat fire, a dense growth of ragweed, smartweed, or aspen sprang up from the ashes. The cyclic ^{boom} of 1932 coincided with tremendous temporary growths of weed foods following the fire of 1930. During the period 1932-1934 prairie chickens and quail reached an all-time high. This was followed by the cyclic crash of 1936, which coincided with a killing winter and the wholesale replacement of weed foods by aspen thickets. The resulting decimation of wild life was sudden and severe. It has no counterpart in Wisconsin history, save only the extirpation of the passenger pigeon.

Stage 4: 1938. Reflooding.

The 1930 fire proved that control of fire in peat is impossible except by reflooding. C.W.A. funds became available in 1933, and were used to build dams in ditches. Later the Resettlement Administration secured funds to move farmers out, and to reflood large parts of the marsh. These flowages had the effect of increasing waterfowl and drowning part of the aspen thickets which threatened to swallow up the whole terrain.

A radical shift of flora and fauna is now in process. The depopulation of farms and the spread of aspen scrub has increased deer and beaver and brought in bears, but nearly eliminated prairie chickens and quail. The prairie flora, evicted from the southern prairies, has invaded many abandoned fields and sand islands. The old haymeadows are nearly all gone. Many peat beds, wholly or partially consumed by former fires, now float in flowages or present a raw surface on which no useful plant can grow. The cranberry industry has prospered, and is impounding more water yearly.

The net effects of the ecological overturn are as yet by no means clear. Can one raise muskrats and cranberries in the same marsh? Will the new flowages now productive of waterfowl remain so through future stages of the aquatic succession? What vegetation will follow the aspen scrub? Can a permanent deer herd be maintained without coniferous swamps for wintering? Can the cranes adapt themselves to their new environment?

Figure 16b: Case 4: History of Central Wisconsin Marshes

Literature

For a literary description of the ecological history of this region, see:

Leopold, Aldo. Marshland elegy. American Forests, Vol. 43, No. 10, October, 1937. pp. 472-474.

For technical papers see:

Hamerstrom, F. N. Jr. A study of Wisconsin prairie chicken and sharptailed grouse. Wilson Bulletin, Vol. 51, No. 2, June, 1939. pp. 105-120.

Hamerstrom, F. N. Jr. and James Blake. Winter movements and winter foods of whitetailed deer in central Wisconsin. Jour. Mammalogy, Vol. 20, No. 2, May, 1939. pp. 206-215.

Hamerstrom, F. N. Jr. and James Blake. Central Wisconsin muskrat study. American Midland Naturalist, Vol. 21, No. 2, March, 1939. pp. 514-520.

Schorger, A. W. The great Wisconsin passenger pigeon nesting of 1871. Proc. Linnaean Soc. of New York, No. 43, 1936, New York, 1937.

Schmidt, F.J.W. Winter food of the sharp-tailed grouse and pinnated grouse in Wisconsin. Wilson Bulletin, Vol. 48, No. 3, September, 1936. pp. 186-203.

Leopold, Aldo. The Wisconsin river marshes. National Waltonian, September, 1934.

For geology of this region see:

Martin, L. The physical geography of Wisconsin. (2nd edition) Bull. 36 Wis. Geol. and Nat. Hist. Survey, Madison, 1932. pp. 125, 338.

Questions

1. What now eats the mast which once attracted passenger pigeon nestings? Did the mast which fed the 1871 nesting form in 1871?
2. Explain in terms of plant foods the present scarcity of prairie chickens and quail. Why did sharptails fare better than chickens?
3. The Cambrian sandstones which feed the wells of western Wisconsin outcrop here. Speculate on the probable effect of this history on the water supply in these strata.
4. There is still some haying in the marsh, especially in dry years when upland hays are scarce. In wet years few meadows are mowed. This enables one to predict in what years spring flies are likely to be set. How?

Figure 16c: Case 4: History of Central Wisconsin Marshes

Figure 16d: Case 4: History of Central Wisconsin Marshes

The scenario matched the four levels (KPS1), (KPS2), (KPS3), (KPS4) of performance for Knowledge of Processes and Systems because of the various span of species and illustrative examples that demonstrate reciprocity, feedback, patterns over time, and broader application of how the ecosystem is operating on the various levels when it is altered over time. The scenario matched the four levels (EPS1), (EPS2), (EPS3), (EPS4) of performance for Environmental Problem Solving as humans are involved in the changes that happen over time to the marsh and the cultural context that pioneers, farmers and the cranberry industry bring to the marsh as it was altered to meet the criteria of human demands. Questions 1 through 3 for students required an understanding of the ecological habits of species as well as a geographical understanding

of soils and aquifers. Question four requires prediction based on knowledge about specific needs of spring fly populations. These four questions aligned with the four performance levels (KPS1), (KPS2), (KPS3), (KPS4) of Knowledge of Processes and Systems.

Data Source 11: Case 5: History of Northern Wisconsin

This case is the most descriptive of an ecological disaster where humans had total disregard for the biotic community (Stages 1 to 4). The student was introduced to the diverse biological setting of a forest community. The forest community was interrupted by the logging industry, followed by the settler. Leopold defined a settler as one that “has poor crops, but ekes out a living by working in the logging camps.” Over a 20 year period the forests were completely wiped out by the logging industry and the settler became a “bootlegger, commercial poacher or a resort employee.” At the end of this scenario, wide range havoc occurred with the biological species completely out of balance, “broadly speaking, there is not a valuable plant left on the landscape.”

Case 5: History of Northern Wisconsin

Stage 1: 1880. This terrain originally presents three "types":

<u>Type</u> (soil)	<u>Trees</u>	<u>Understory</u>	<u>Distinctive animals</u>
cedar swamp (muck soil)	white cedar, white spruce (uneven aged)	alder, berries	woodcock, spruce hen, brook trout, snowshoe, otter, red squirrel, marten
Norway pine (outwash sand)	Norway pine (even-aged groups)	sweet fern, bearberry	
Hardwood (Boulder clay moraine)	maple, yellow birch, hemlock, white pine (uneven aged)	yew, striped maple	pileated woodpecker

The fauna is rich in species but poor in density. Notice that the cedar swamp occupies the least area but harbors the greatest number of characteristic animal species.

Notice that the forest types differ in age-composition according to their shade-tolerance.

Stage 2: 1900. Pine Logging

The white pine is the first tree to acquire commercial value. It is cut and driven down the creek. To do this, the creek is cleared of boulders, logs, and sharp turns.

The Norway pine is cut next. This creates a large "slash," which burns repeatedly, thus preventing reproduction. A settler establishes a homestead on the slash. This is poor sandy soil. The boulder-clay upland is much better soil, but more expensive to clear. The settler has poor crops, but ekes out a living by working in the logging camps.

The settler, combined with fire, grazing, and cultivation, introduces many new plants: white clover, bluegrass, agricultural weeds. These in turn are followed by new animals: sharptail, cottontail, and feral house cats. Ruffed grouse increase because of the white clover and brush growths.

The settler, by his trapping and hunting, eliminates several mammals: bear, marten, fisher, otter, lynx. Deer decrease, despite the increase in deer foods, by reason of the settler's poaching activities.

(In some localities, where wider areas are cleared by fire and cultivation, the shift in fauna is more radical. Prairie chickens become the principal game bird; deer and ruffed grouse disappear.)

bad
water
in mud

Figure 17a: Case 5: History of N. Wisconsin

3100

Notice that the cedar swamp and the hardwood moraine remain virtually intact in both flora and fauna. The exploitation of those trees is not yet profitable, and the only animals removed from these habitats are the mobile and salable fur and deer. The decrease in deer pressure augments undergrowths palatable to deer: yew and striped maple on the moraine; cedar reproduction in the swamp.

Stage 3: 1920. Hardwood Logging.

The hardwood is now slashed, and likewise the cedar posts and spruce pulpwood in the swamp. The pileated woodpecker disappears with the hardwood; the spruce hen with the swamp timber.

The settler holds out as long as he can work in the logging camps, but after all commercial timber is gone he becomes either a bootlegger, commercial poacher, or a resort employee. In any case he no longer needs his homestead, so it reverts for taxes and springs up to aspen, birch, and pincherry scrub.

This scrub, plus the sprouting hardwood stumps, plus the accumulated reserves of deer food resulting from the preceding nearly deerless period, plus the extermination of wolves and the bounty on cats and coyotes, jointly produce an "irruption" of deer. Every November the scrub swarms with hunters. The Conservation Commission is pleased with the effectiveness of its deer policy.

Stage 4: 1938.

G.C.C. truck trails have now made this area accessible to fire-fighters, hunters, fishermen, and wardens.

Fire protection closes the canopy of the scrub growths and suddenly shades out deer and grouse foods. Sharptails disappear. The deer have eaten up the reserves of yew, striped maple, and young cedar. The near-extinction of all carnivores further increases the disparity between deer population and deer carrying capacity. The buck law distorts the sex ratio. Almost without warning the deer begin to starve in winter, to harbor "pneumonia" and parasites, to decrease in weight and antler development, and to exhibit abnormal dispersion of rutting and fawning dates. Yew and young cedar disappear, and the deer turn to young pines for food.

Meanwhile the snowshoes, waxing unduly abundant in the continuous scrub, develop an exaggerated population cycle. With the help of the deer, they extinguish all palatable undergrowth.

The wholesale spread of scrub allows re-invasion of the terrain by bear and beaver. The depopulation of homesteads allows of re-invasion by otter. The otters, however, are kept at a low level by fishermen, who, having fished out the original brook trout, have stocked the stream with exotic trouts. The stream now depends on artificial stocking and heavy predator-control to sustain even a poor fish population.

Broadly speaking, there is not a valuable plant left on the landscape. The remaining land animals are either violently cyclic, subject to winter starvation, or held at low levels for their alleged predation, or for their fur value. The fish fauna is artificialized, unproductive, and dependent on artificial restocking.

Figure 17b: Case 5: History of N. Wisconsin

Questions

1. What game bird is still uninjured in the 1938 stage? Why? *woodcock*
2. What plants account for the re-invasion by beaver in the 1938 stage? *clearing*
3. If fire follows the hardwood logging, what deer food is decreased instead of increased? *best ? year, striped as*
4. What game species benefit by the introduction of white clover? *N. glauca*
5. Speculate as to why there is no comprehensive published account of northern Wisconsin ecology, when it affects the welfare of half the state?
6. What harm and what benefit would result from the reestablishment of a limited number of wolves on this terrain?
7. To convert an overstocked deer range from Stage 4 to a healthy condition, what criteria of health would you suggest (a) for the range? (b) for the deer?
8. Why did the abuse of land in Case 2 result in erosion, but not in this case where one hears nothing of erosion?

- 1) normal cutters
- 2) " sex ratio
- 3) " weight
- 4) " dispersion of
 - a) hunting
 - b) bowing
- 5) lack of starvation in winter
- 6) " " diseases
- 7) pop. in close conformity to food reserves
- 8) healthy num. of predators

- 1) reproduction
- 2) % of palatable

podzol soil is caused by hard pan for certain layers
 conifer land is composed of loessial soil on long slopes with longer grassy areas

Figure 17c: Case 5: History of N. Wisconsin

Figure 17d: Case 5: History of N. Wisconsin

This case met all four performance criteria (EPS1), (EPS2), (EPS3), (EPS4) for Environmental Problem Solving and shows the progression of human ties with a natural environment that changed the context of the culture and ecology over time, in a negative impact. The forest ecology was severely interrupted by human activities and the repeated patterns of abuse changed the economics of the individuals who moves into the forested area as well as the logging industry. Recreational tourism was introduced to the area but, poorly managed by government regulations, resulted in environmental conditions that required artificial means to sustain any level of game species.

Questions for the students included Strands Question and Analysis, Knowledge of Processes and Systems, and Environmental Problem Solving. Questions 1 through 8

identified local environmental problems which is a Beginning (QA1) for Question and Analysis. Questions 1, 2, 3 and 4 require mastery (KPS4) for Knowledge of Processes and Systems as students had to know the specific habits and identity of various species, the connections of specific species to the ecological community, and how different situations affected the operation of the ecosystem on various levels. Questions 5 and 8 are very specific to the geopolitics of natural resource management which matched the Mastery (EPS4) performance level of Environmental Problem Solving. Questions 6 and 7 are Accomplished (KPS3) (EPS3) performance levels under Knowledge of Processes and Systems and Environmental Problem Solving because students examined the connections of reciprocity and feedback of the wolf and deer in a community as well as compared how both species adapted to various changes in their respective environments.

Data Source 12: Case 6: Evolution of a Fencerow

For this case, (Figure 18a to 18d), fence was introduced as a cultural artifact that changed in structure to meet the economic necessities of society over time. The structure and composition of the fence, from wood to wire, changed as the needs of the local community shifted. With each change, local habit is affected.

Case 6: Evolution of the Fencerow

Stage 1: 1840. Log Fences.

The first fences were built to keep the stock out of crops, rather than to confine the stock in pastures. In wooded country these fences were built out of whole round logs rather than rails. Tops and brush were often used to reinforce the structure.

Such fencerows were often 30' wide and included a generous "turn around" of sod on each side. The flora and fauna included practically all but the most shade-tolerant species of plants, and all but the wildest species of forest game. Even wild turkeys used such fencerows as travel lanes.

Stage 2: 1860. Rail Fences and Hedges

Split rails were substituted for round unsplit logs. Even the rails, however, left triangles of uncultivated ground, which could not be burned without losing the fence, and which could not be mowed except by hand and after laborious debrushing.

The flora and fauna remained as in Stage 1. The rail-fence stage of American agriculture saw the richest profusion of small wildlife ever recorded on this continent.

Noxious weeds had little chance to gain a foothold during either Stage 1 or Stage 2 fencerows. The vigorous competition of native shrubs, herbs and grasses largely precluded weeds.

In prairie country the osage orange hedge took the place of the rail fence. Its cover value for wildlife was at least equal to the rail fence.

Stage 3: 1900. Wire Fences

Barbed wire began to replace split rails as straight durable timber became scarcer and cheap wire became more abundant. The first wire fences in Wisconsin came in about 1880. Galvanized wire, both barbed and woven, came in about 1900. A boom in land values accompanied the change, and encouraged the clearance of brush and the narrowing of "turn-arounds." The abandonment of rails also facilitated the use of fire for clearing fences, although wooden posts still prevented firing during very dry weather, or where posts were very rough or partially decayed.

During the barbed wire stage, the wildlife cover value of fencerows was greatly reduced. Most fencerows lost their usefulness as winter cover and became usable only for nesting cover and as travel lanes. The radical narrowing of the fencerow gave the posts a new value as observation stations for egg-hunting crows.

The fencerow fauna and flora were greatly reduced. Noxious weeds had a lesser width of row to grow in, but they had a better chance to get started by reason of the more frequent and complete disturbance of competing vegetation.

Figure 18a: Case 6: Evolution of a Fencerow

Stage 4: 1925. Metal and Concrete Fences

Metal posts began to come in about 1915 and were widely used by 1925. Concrete posts came in at about the same time.

Non-burnable posts gave the final and complete release to fire as a tool for clearing fences. This encouraged grasses and discouraged brush species as fencerow cover.

This stage coincided with the wholesale extension of quack grass and sweet clover in fencerows, a further decrease in width of fencerows, and a further shrinkage in floral and faunal lists.

Metal posts increased the "mobility" of fence lines. A temporary fence implies that the fencerow, if on broken ground, will be occupied by weed stages of the plant succession.

Stage 5: 1938. Electric Fence

Electric fences came into Wisconsin in 1935 and are now widely used. They are often employed to bolster up tottering wire fences, and to this extent they "widen" the fencerow and benefit wildlife. Ultimately, however, electric fences mean the complete subjugation of fencerow growths. No kind of cover can be tolerated in an electric fence because of short-circuiting during rains.

Summary of Wildlife Ecology of Fencerows

<u>Stage</u>	<u>Kind of fence</u>	<u>Usual width</u>	<u>Could fire be used?</u>
1	log	20-30 feet	no
2	rail or hedge	20 feet	no
3	wire	5-10 feet	partly
4	metal and concrete	5-10 feet	yes
5	electric	zero	yes, if posts are metal

Questions

1. Why do English farmers, who need acreage worse than we do, continue to use hedges for fence purposes?
2. Were rail and log fences a good refuge for prairie flora?
3. Why are relics of prairie flora usually confined to railroads and highways?

Figure 18b: Case 6: Evolution of a Fencerow

Literature

Although fencerows are mentioned in hundreds of publications on wildlife management, there has been no ecological experimentation to measure their effects on animals. The best paper is: 11

Elmendorf, F. C. The farm fence in wildlife management and erosion control. Trans. Third North Amer. Wildlife Conference, 1938, pp. 583-591. (Reprinted in Pennsylvania Game News, March-April, 1938.)

There is a large literature on windbreaks. The extension services of Wisconsin, Minnesota, Iowa, and also the Illinois Natural History Survey, issue farmers' bulletins on them. Also see:

Bates, Carlos G. The windbreak as a farm asset. U.S.D.A. Farmers' Bul. 1405, 1936.

The windbreaking effects of fencerows can be inferred from:

Aust, E. A. Effects of trees on wind velocities. 15th Annual Meeting Highway Research Board, 1935, pp. 112-121.

Figure 18c: Case 6: Evolution of a Fencerow

Figure 18d: Case 6: Evolution of a Fencerow

This case matched all four levels (EPS1), (EPS2), (EPS3), (EPS4) of criteria for Environmental Problem Solving. The case stripped away the observable landscape and provided the underpinning layers of cultural context that changed environmental conditions over time as technology changed the fence structure. The change in the structure of the fence, from wood to metal, had a devastating effect on local habitat. The overall example of this case demonstrated how daily impacts of personal choices changed the environment which matched the Mastery (PCR4) level of Personal and Civic Responsibility.

Student question one asked students to compare the English farming practices to American farming practices which is a mastery (EPS4) level question for Environmental Problem Solving. Student question two and three (EPS2), (EPS3) are accomplished level questions for Environmental Problem Solving because students examined the connections of prairie flora to the ways they have adapted to changes in their environments.

Data Source 13: Case 7: History of a Tussock Marsh

For this case a glacial drainage resulted in a marsh that is changed over time due to farming practices. At one point, change resulted in a burst of plant and animal diversity but that receded with the pressure of intensified cattle grazing. Water was gradually channeled into a ditch system and the drainage of the basin eliminated the marsh.

Case 7: History of a Tussock Marsh

This terrain is a spring-fed swale characteristic of glacial drainage. Such swales are found between drumlins, along sluggish creeks, or around marshy lakes. The soil is muck, possibly representing decayed peat.

Stage 1: 1890. The marsh is a monotype of Carex stricta, which has formed tall tussocks* or hummocks by the rising action of its brace roots. The coarse grass on these tussocks forms a canopy which largely shades out other vegetation. In wet seasons the tussocks are flooded. They form perfect cover but bear no food and support few animals.

The spring meanders through the tussocks in a series of pools grown to bur reed, wapato, cattail, and sedges. In the cold water near the spring is crayfish and trout.

Around the edges of the marsh is a fringe of red dogwood.

The animal community depends largely on the pools rather than on the tussocks. The birds include 2 ducks, 2 rails, 1 grebe, 2 blackbirds, marsh wren, and swamp sparrow. The characteristic mammal is the jumping mouse, which inhabits the tussocks, and supports two shrews. Musk rats inhabit the pools and support minks.

Stage 2: 1910 The marsh is now grazed but not drained. The grazing and trampling of tussocks has killed part of the sedge and replaced it with red top, which sods over the tussocks as if it had formed them. The muddy trails between the tussocks now support jacksnipe. These trampled areas have admitted two annual weeds, Bidens and smartweed, both good bird foods. Prairie chickens, forced down off the upland by intensive cultivation, use the partly-opened tussocks as winter roosts. The cattle have eliminated the cattails in the pools and hence the yellow-headed blackbirds, but the new short-grass pasture on the edges of the marsh has admitted meadowlark, bobolink, and cottontail. With the combination of cottontails and mice for prey, weasels have followed.

The partial disturbances of Stage 2 have raised the mammals from 5 to 7 species, and the birds from 9 to 11 species. These gains come from breaking up the monotype of Carex.

Stage 3: 1920. The marsh is now drained and grazed. The aquatic community of the pool is gone, save only for water grass, which is protected from cattle by the steep new ditchbank, and has followed the swift-running water down from the spring.

The complete accessibility of the tussocks, plus the lowered water table, has now allowed the cattle to kill all the Carex. Red-top covers the wetter and

*See Costello, D. F. Tussock meadows of southeastern Wisconsin. Botanical Gazette, Vol. 97, No. 3, March, 1936, pp. 610-648.

Figure 19a: Case 7: History of a Tussock Marsh

bluegrass the drier ~~part~~ of the marsh. The old tussocks, however, still localize the trampling by cattle, and this produces abundant annual weeds, including Bidens, smartweed, and in dry years vervain and lesser ragweed. All type lines have moved downhill, but they still oscillate up and down hill with wet and dry years.

Jacksnipe now visit the marsh only as migrants and only in wet years. Prairie chickens no longer find roosting cover, but visit the marsh occasionally to eat weed seeds or loaf. The superior denning facilities offered by the ditch-banks have admitted skunks. Meadow mice have replaced jumping mice, and the dry-land sparrows the swamp-land sparrows.

The mammal list has now fallen from 7 to 6, the distinctive birds from 11 to 6.

Stage 4: 1930 Continued grazing and drying have further moved all types downhill. Ragweed now grows yearly in the cattle trails, instead of only during drouths. The sluffing banks of the ditch have allowed the cattle to clean out the cress, which is replaced by smartweed.

Pheasants are now introduced and use the marsh for summer nesting, and for feeding on ragweed and smartweed in winter. Killdeer, meadowlark, and the short-grass sparrows have become abundant. The meadow mouse is replaced by the prairie deer mouse.

The mammal list has fallen from 6 to 4, the bird list risen from 6 to 7. The fauna and flora, however, are that of the upland prairie. Save for the tombstone-tussocks, it is no longer a marsh.

Questions

1. Is tussock marsh a climax type? If not, what succeeds it?
2. If the black muck is decayed peat, what arrested the process of peat formation?
3. What stage of the plant succession in tussock marsh supports the richest fauna and flora? Why?
4. Trees in drained tussock marshes frequently occupy the tops of pedestals or raised mounds. Why?

Figure 19b: Case 7: History of a Tussock Marsh

Figure 19c: Case 7: History of a Tussock Marsh

This case contained the four levels (KPS1), (KPS2), (KPS3), (KPS4) of performance for Knowledge of Processes and Systems. The local flora, fauna and geography with each stage of progression, life cycles, feedback and ecosystem operations are specifically identified. In Stage 1, the marsh was dominated by a monoculture of *Carex stricta* with the outer edges of springs supporting small numbers of birds and mammals. In Stage 2 with the introduction of cattle, the monotype was broken down allowing for the intrusion of annual weeds that supported a wider variety of wildlife. Stages 3 and 4 continued the case of poor agricultural practices that reduced ecological diversity. The introduction of the human connections with the marsh environment and the patterns of relationships, adaptations and cultural contexts of agriculture fit all four

performance (EPS1), (EPS2), (EPS3), (EPS4) levels for Environmental Problem Solving.

The student questions were directed toward Knowledge of Processes and Systems. Questions 1 and 3 are Developing (KPS2) category questions because students identified stages of patterns, such as climax and other successive stages of ecosystems. Question 2 and 4 (KPS3) examined the underlying factors that influenced the connections to form peat bogs and allow for tree proliferation on raised mounds. Both of these questions are Accomplished categories.

Data Source 14: Case 8: History of Gilbert Creek, Dunn County, Wis.

Leopold included work of some of his graduate students in Wildlife Ecology 118. The History of Gilbert Creek was compiled by graduate student Irvan O. Buss. Buss did most of his research on the Upland Sandpiper under Leopold's tutelage, at the Faville Grove research site (McCabe, 1987). This history is over a relatively short period of 18 years to show how quickly an ecosystem was altered by farming practices

Case 8: History of Gilbert Creek, Dunn County, Wis.
(compiled by Irvan O. Buss)

Stage 1: 1920

A fertile creek bottom is covered with alder thickets and woods of ash, swamp oak and elm interspersed with small grassy meadows. A cold stream meanders eastward toward the Red Cedar River. The farmer does not use the bottom, for it is too wet for cultivation. His firewood is cut from the adjoining hillsides, which produce tall, straight pigmy hickory, red oak and hard maple.

The diverse flora and topography support 15 mammals and 15 breeding birds. The overhanging banks, whirlpools, sandy bars and rapids of the deep stream provide an excellent habitat for brook trout. Common suckers and crayfish are plentiful.

Stage 2: 1925

The farmer clears the woods bordering the stream and turns his cattle to graze the meadow and slashings. The swamp oaks are cut into fence posts which are sold to pay for new machinery. The slopes are still being cut for fire wood, since hard maple and hickory furnish excellent fuel, and red oak is easy to split. The large elms cut from the bottom are left to rot--they are too difficult to work into wood and do not bring a high price for lumber.

Removing the woods eliminates the coyote, foxes, all four species of squirrels, chipmunk, and deer mouse. Grazing drives out the star-nosed mole and the jumping mouse. Raccoons are decreasing; only those living on the wooded slopes come down to the stream at night to feed. Removing the woods has caused the ground to become drier, thus benefitting the skunk, rabbit and weasel. The badger moves closer to the stream. Near the end of this stage, the ground becomes dry enough to allow the prairie mole to live in the meadows.

Modifying the flora to this extent has reduced the bird fauna from 15 to 3 species, and the mammals from 15 to 11 species.

Removing the shade from the water has caused it to become warmer. Brook trout can no longer exist in it; therefore brown and rainbow trout are planted as substitutes.

Stage 3: 1930

The farmer has burned the slashings; increased grazing has nearly exterminated the Carex, which is replaced by Bidens, smartweed, and June grass. The edges of the stream are eroding as the roots of the alders and Carex are killed. The warmer water now contains carp which have "run" up the creek from the river. The carp begin destroying the remaining vegetation at the stream's edge, thereby making it wider and increasing its temperature.

Figure 20a: Case 8: History of Gilbert Creek, Dunn County, WI.

The number of species remains the same, but the density of all mammalian species except striped gophers and prairie moles has been greatly reduced. Bird populations remain about the same.

Stage 4: 1938

The farmer has removed nearly all the trees from the slopes of the valley. The spring rains cause floods, which run red with the clay of the slopes. Each year the bottom is covered with a layer of silt which annually renews the crop of giant ragweed, smartweed, and nettle. Since most farmers on the watershed have "improved" their farms in the same way, there is a sharp increase in the frequency and intensity of floods.

The stream is now so shallow and warm that it contains no trout; catfish have increased; bullheads live in every pool; turtles (including Blanding's turtle) are common and use the sloping banks as egg depositories.

Most of the remaining mammals have become scarce; the woodchuck and badger have moved to the plateaus above the valley. Pheasants are increasing. The starling has invaded the region. The avian fauna now includes 3 species instead of 15, the mammalian fauna 9 species instead of 15.

Figure 20b: Case 8: History of Gilbert Creek, Dunn County WI.

History of Gilbert Creek, Dunn County
(compiled by Irvan O. Buss)

4 squirrels
Raccoon
Mink
Muskrat
Microtus
Chipmunk
Jumping mouse
2 foxes
Coyote
Deer mouse
Star-nosed mole

Ruffed grouse ✓
Quail (winter) ✓
Woodcock ✓
Indigo bunting ✓
Brown thrasher ✓
Barred owl ✓
Horned owl ✓
Screech owl ✓
Blackbird ✓
Pileated woodp. ✓
Redheaded woodp. ✓
Swamp sparrow ✓
Kingfisher ✓
Wood thrush ✓
Grosbeak ✓

Raccoon
Mink
Muskrat
Microtus
Weasel
Skunk
Rabbit
Woodchuck
Striped gopher
Prairie mole
Badger

Redheaded woodp. ✓
Blackbird ✓
Vesper sparrow ✓
Field sparrow ✓
Kingfisher ✓
Pheasant ✓
Meadowlark ✓
Bobolink ✓

Raccoon
Mink
Muskrat
Microtus
Weasel
Skunk
Rabbit
Woodchuck
Striped gopher
Prairie mole
Badger

Redheaded woodp. ✓
Blackbird ✓
Vesper sparrow ✓
Field sparrow ✓
Kingfisher ✓
Pheasant ✓
Meadowlark ✓
Bobolink ✓

Raccoon (scarce)
Mink (scarce)
Muskrat
Microtus
Weasel (scarce)
Skunk
Rabbit
Striped gopher
Prairie mole

Redheaded woodp. ✓
Blackbird ✓
Vesper sparrow ✓
Field sparrow ✓
Pheasant ✓
Meadowlark ✓
Bobolink ✓
Starling ✓

Figure 20c: Case 8: History of Gilbert Creek, Dunn County, WI.

This case fit the strands for Knowledge of Processes and Systems in all four levels (KPS1), (KPS2), (KPS3), (KPS4). The identity of flora, fauna and geography was given and the changes are noted throughout the process of 18 years as the ecosystem is altered. When geography changed, as in the example of how the creek water warmed due to the effect of removing the nearby woods, the species of fish changed in the creek because the temperature of the water rose. The history demonstrated how ecosystems operated on various levels by demonstrating that the water quality was affected by the change in nearby slopes and meadows.

The cultural context of agricultural practices was emphasized and matched the four criteria levels (EPS1), (EPS2), (EPS3), (EPS4) of Environmental Problem Solving. The effects of cattle ranching over time created pressure on the landscape that changed the environmental conditions. Wildlife potential was decreased as soils eroded and plant life was modified.

Data Source 15: Conclusions of Case Histories

Leopold developed a slide program and an interpretation of the case histories. The purpose of the cases was to demonstrate how human pressures on land use dramatically altered the plant and animal communities. He identified the definition of best conservation practices of land use.

INTERPRETATION OF CASE HISTORIES

These Wisconsin landscapes, and all others elsewhere, have one mechanism common to all. In any given soil and climate:

1. The animal community is determined by the plant community (food and cover).
2. The plant community is determined by land-use (farming, grazing, fire, drainage, lumbering, hunting, road-building, etc.)
- Land-use acts on two things:
 3. The Plant Succession (the sequence of plant coverings inherent in the soil, viz: weeds, forbs, grass, shrubs, timber)
 4. The Soil and Water System (fertility, runoff vs. infiltration, erosion, floods, etc.)

The rest of this course is an elaboration of why and how this mechanism works, what causes it to get out of order, how it can be kept working smoothly.

Note that the mechanism contains only one variable subject to human control: land-use. All other parts are fixed attributes of animals, soils, plants, and waters. Those attributes can be learned and used, but never changed.

What are the criteria of conservative land-use, i.e., land-use which avoids undesirable dislocations of the land-mechanism? Land-use is conservative when it:

- (5) {
5. Preserves the fertility of soils
 6. Preserves the stability of water-systems
 7. Yields useful products
 8. Preserves native fauna and flora as far as possible
 9. Avoids the escape of diseases and pests

ASSIGNMENT No. 1 (not over one page):

(A) Draw from the cases, or lectures, or your own experience, specific examples of 1, 2, 3, 4.

(B) Classify the following human groups in relation to their comprehension of 5, 6, 7, 8, & 9: County Agricultural Agent, Sportsman, Erosion Engineer, Forester, Farmer.

(If you are unfamiliar with any of these, substitute other groups of your own choosing.)

Figure 21: Case History Summary

After summary of case history and definition of land use, Leopold made two assignments. Assignment No. 1 matched Developing and Accomplished (KPS2), (KPS3) for Knowledge of Processes and Systems. Students would show examples from personal experiences or class lessons, that required broad application of the way ecosystems operate on different levels and showed examples of cultural impacts on plant and animal communities. Assignment No. 2 matched the Mastery (EPS4) level for Environmental Problem Solving. Students would show how the culture of various professions can impact the environment.

Data Source 16: Biography of a Flock

Leopold wrote three biographies for Wildlife Ecology 118 that detailed the life histories of particular species throughout the course of a year. Biography of a Flock (Figure 22a to 22c), began with a flock of 10 pheasants in January. As the year progressed the flock went through population fluctuations due to predation, farming practices, season changes, nesting and hatches, roadways, and hunters. Leopold included a hand drawn map that showed the location and activities of the pheasants.

BIOGRAPHY OF A FLOCK

10 pheasants - southern Wisconsin

JANUARY: Ten pheasants roost in the cattails of the marsh at A, feeding on cornshocks which have been left at B. They use the marsh as mid-day loafing-ground.

The frozen ground offers good hauling, so the farmer finishes hauling the shocks to the farmyard. The pheasants now feed at corn shocks (C), walking up the fence line and crossing the road. The ragweed in the oat stubble (D) provides supplementary feed en route.

The neighbor hauls in the corn from C. The pheasants now feed on the soybean stubble (E), returning to the marsh to loaf and roost.

Snow buries most of the soybeans, which are lying nearly flat on the ground. There is no other food except the feedlot (F), which the birds try to use, but subject to interruption by the farm dog. The birds eat dried grapes from the vines on the fencerow (G) and also pick up acorn crumbs from the squirrels in the woods, and a little ragweed remaining in the stubble.

The neighbor begins spreading manure at H. The birds feed there, walking via fencerow (G) and the road ditch (I).

A thaw now crusts the snow, making travel easy, and exposing various widely-scattered feeding grounds. The flock ranges a full mile each day, flying or walking from one feeding spot to another. Sometimes evening finds them so far afield they have to fly back to the marsh in semi-dark.

A blizzard makes an end of this, and even buries the roosting ground in the cattails. They try roosting in the willows (J), but a horned owl makes a kill, leaving 9. Two other birds lose their tails when a sleet glues them to the ground.

They fly nightly to the evergreen windbreak (K) to roost. The farmer has now cut wood at L, and they loaf in the cover offered by the brushpiles. They forage locust beans at M and burdocks in the fencerows.

FEBRUARY: More snow comes. A fox scores on one of the tailless birds who is slow in dodging, leaving 8 birds. Another neighbor spreads manure at N. The birds fly to it, as the snow is soft and walking difficult.

A horned owl discovers the roost (K) and scores, leaving 7. The birds are forced back to the marsh to roost in the willows where the owl scores again, leaving 6.

A thaw uncovers the cattails and all the old manured fields. Times pick up.

Our own farmer puts out manure at O. Still better.

MARCH: Easy going but for occasional temporary snows.

APRIL: The 6 remaining birds form 2 harems, of a cock and 2 hens each.

*should be only
(Turner paper)*

Figure 22a: Biography of a Flock

MAY-AUGUST: One cock claims a crowing ground on the marsh. His hen (a) nests in the marsh but her eggs are flooded. His hen (b) nests in the woods and brings off a brood of 8, 2 of which fall to a gopher; the rest survive. The other cock crows in the fencerow; both of his hens (c & d) nest in the hay and are caught in the mowing. Both lose their eggs, and one her life also. Hen a, who was flooded, now renests in a fencerow, bringing off 7, losing 1 in a pelting rain, and 2 when the brood is scattered by a marsh hawk. Hen c renests but is caught in the oats harvest.

SEPTEMBER: Survival: 14 pheasants, 5 old, 9 young. No ^{further} mortality.

OCT.-DEC: Hunters get 3, and 1 dies a cripple. Survival 10, as of a year ago.

Population Curve - 10 pheasants

Figure 22b: Biography of a Flock

Figure 22c: Biography of a Flock

The Biography of a Flock used Developing (QA2) criteria for Question and Analysis by using a map (Figure 22c) to gather information for studying the life history of the pheasant. Emphasis on data gathered from observation would also fit the Developing criteria. The Biography also aligned with the four rubric criteria levels (KPS1), (KPS2), (KPS3), (KPS4) of Knowledge of Processes and Systems. Students became aware of the intricate life cycles and patterns of the pheasants (Figures 22a and 22b). Leopold used the hand drawn map for students to visualize the range, territory, and seasonal changes of the ecosystem on the pheasants throughout the year. The description provided a broad look at the operation of the ecosystem on the pheasants and their adaptations to their environment.

The Accomplished (EPS3) and Mastery (EPS4) levels for Environmental Problem Solving were demonstrated by the ways the pheasants adjusted to the various situations. Students became familiar with the various organizational behaviors within a given species during the course of the year. Students were shown how the cultural context of the farmer's activities affected the behavior and physiology of the pheasants. The pheasants adjusted their diets, their nesting habits, and their range as the farmer's activities changed.

Data Source 17: Biography of a Great Horned Owl

In this biography a local environmental problem was identified between the relationship of the great horned owls and the farmer. The farmer only saw the owl's presence as a negative asset. The benefit of owls to control rodent population for the farmer's crops was negated by the first owl pair that preyed on the farmer's chickens.

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Wildlife Ecology 118
(Revised 1943-44)
Aldo Leopold

Plenty

BIOGRAPHY OF A HORNNED OWL TERRITORY

Frances Hamerstrom

December

G-105 A male owl hoots from the woodlot at every dusk and dawn. He has staked out the woodlot as his territory, and is warning other males to keep out.

Having served due notice on the dusky world, he proceeds with his hunt. There is no snow as yet, and the frosts have thinned the ground cover; hence mice are easy meat. We know this because December pellets show mostly deer mice, even when meadow mice are more abundant.

Another owl, presumably his mate, cohabits the territory.

1144 Toward Christmas, a snow makes mouse-hunting harder and rabbit-hunting easier. The pellets show this shift.

The pellets also show several quail skulls. Those the owls catch from a covey which, by reason of a good nesting season, was evicted from good quail range, and settled in the owls' woodlot.

January

1496 The two owls have now paired, and roost by day near an old crow's nest which they repair. One roost is a leafy white oak, another a grapevine; both help screen the owls from crows.

641 The male defends the territory against all other owls, of whatever kind.

Rabbits are still the staple food; when mice are caught, it is mostly deer mice, for the meadow mice are now under the snow. A mousing weasel is caught and eaten; and the next day a snow-white pellet lies under the roost tree.

1135 As winter progresses, the female hoots after the male, fairly "taking the words out of his mouth" with her higher call of five or six notes. They are now mating.

February

1386 The first egg is laid in the crow's nest, and incubation starts at once. A second and third egg follow. The farmer is now making wood, and often flushes the incubating female, but fortunately he hugs the stove on very cold days. But for this, the eggs would freeze.

1727 A snow followed by rain and cold causes several roosting pheasants to lose their tails. The owls score on a tailless bird; also on a muskrat wandering across-country from a distant pond.

Figure 23a: Biography of a Great Horned Owl

346

2

March

452 The young owls hatch, but not all at once. The first to hatch has had several good meals of cottontail, and of mice now exposed by thaws, before the youngest emerges. At feeding time the two older owlets trample the youngest, who fails to get his share and soon starves. His brother and sister eat part of his breast and head.

The male owl brings from the marsh a long-tailed jumping mouse, just out of hibernation.

1267

The young owls, still in downy white, are growing fast, for the migrating birds furnish abundant and varied food. Juvenile feathers begin to push out the white down, which floats through the woods and hangs on every bush. A naturalist, bird-list in hand, comes stomping through the woodlot. He sees the down, but not its meaning. Nor does he perceive the cloud of flies buzzing over the nest, which is now smelly with bones, fur, feathers, and the dead owl.

May

Among the flies are some Protocalliphoridae which succeed in laying eggs on the belly of the smaller owlet. The maggots hatch and eat through the skin, making a sore. The two young owls now leave the nest and are taught to fly and hunt. Their parents bring them less food. They are now bigger than their parents, but so clumsy that they seldom catch anything bigger than insects. Crows plague them by day, but are too busy with their own housekeeping to form large mobs.

June

316 The woods are now full of young unwary mice, rabbits, and birds, but despite this peak of abundance, hunger often threatens the clumsy owlets. The young male is hardest put, for the larvae under his belly-skin are large and plump with his blood. They emerge just in time for him to recover.

The busy parents now relax their patrol of the territory; nor are they to be found by day in their former roost-trees, for the whole woods is now heavy with grocery, and crows are busy with their own young.

July

758 The parent owls, increasingly indifferent to their young through June, now become positively hostile, and drive them away from their kills. A young owl, evicted by his parents from a neighboring territory, enters the woodlot and narrowly escapes with his life.

August

The parents now drive their young out of the woodlot, and hoot every evening, perhaps as a warning to all wandering youths. The farmer hears them, and worries about his pullets which are now ranging in the grain stubble and roosting in the orchard. Some disappear, so pole-traps are set. Three evicted juveniles are caught in a week, but the hooting continues. It does not occur to the farmer to

Figure 23b: Biography of a Great Horned Owl

pen up his vulnerable chickens at night. Instead he gets out his gun and succeeds in killing both of the old owls.

One of their young falls to the pole-trap; the other has wandered far. The woodlot, though unguarded, is now owl-less.

September-October

Two new owls take up their abode in the woodlot, for it is a good territory, and they find it empty. Unlike the former pair, they hunt not only in the woodlot, but also around the house and barn.

November-December

1473 The cottontail die-off started this summer, so after the bird migration is past, the new owls fall back on mice, game crippled by hunters, and chickens. The former pair had never learned the knack of catching chickens. Not only had they let the chickens alone, but they had patrolled the farm against all other owls. They were watchdogs for the farm, but to the farmer all owls are equal.

369 No quail are killed by owls this winter, for the nesting season was poor, and the few coveys stick to the best food and cover, where they are not vulnerable.

By January the new owls have built a nest in a high hollow stump.

References:

Errington, Paul L., Frances Hamerstrom, and F. N. Hamerstrom, Jr. The great horned owl and its prey in the north-central states. Research Bulletin 277, Iowa Agr. Exp. Sta., Ames, 1940, pp. 759-850.

Baumgartner, Frederick M. Territory and population in the great horned owl. Auk, 56:274-282.

Figure 23c: Biography of a Great Horned Owl

The biography matched the Beginning (QA1) and Developing (QA2) levels for Question and Analysis. A problem is identified between the farmer and the owls and observational data are collected for information about the species.

The story fit all four levels (KPS1), (KPS2), (KPS3), (KPS4) of rubric criteria for Knowledge of Processes and Systems. Students became familiar with the great horned owl's habitat, where it nested, what it ate through the course of the year as food sources seasonally changed, and what difficulties it had with predator and prey relationships. The parasite relationship of the blow fly and the young owl demonstrated the host relationships of species (Figure 23b). Owl behaviors and numbers of owl species adjusted according to shifts in range and territory. The biography could be extended for broader discussion by examining the relationship between people and predator species.

This lesson also examined and compared how the owls adapted to the changes in the environment, whether it was from the farmer's actions or from the group and individual behaviors of the owls themselves. This fit the rubric criteria for the Accomplished (EPS3) level of the Environmental Problem Solving.

Data Source 18: Biography of a Covey

In addition to natural predators of hawks, owls, weasels and skunks, the covey of quail must succumb to new pressures introduced by humans. Cats, dogs, hunters, farm machinery, and automobiles add challenges for survival throughout the year. For this scenario, students were shown how wildlife managers use weight measurements of species for reliable data concerning health and vitality of the organisms being studied.

BIOGRAPHY OF A COVEY

15 quail - southern Wisconsin

120 JANUARY: The covey is feeding on cornshocks which have been accidentally left at (A), using several grape tangles (B) as daytime cover. They fly to the marsh (C) to roost.

The ground gets hard so the farmer husks out the shocks and hauls the corn to the barn. His place is posted, and he is a quail-lover, but he is unaware that he is jeopardizing his birds. The covey falls back on the ragweed (D) in the oat stubble. (There is plenty of corn $\frac{1}{2}$ mile away, but no cover, hence the birds can't reach it--being of short radius.)

A snow buries the ragweed, so the covey begins to fly to the barnyard to feed. The farmer notes this, and feels a glow of hospitable pleasure over his guests. But the farm dog and cats note it, too. The cats get one. Another dies of cold when the dog scatters them late one afternoon, and the bird fails to rejoin the others. Motor traffic gets another during a sudden disturbance. Twelve left.

The farmer by accident begins to scatter manure on snow in stubble at (F). This is much better than risking the barnyard, so they feed there. Using fence-row (G) as a street, they don't need to fly.

FEBRUARY: Every day the manure-spreader moves farther from the fence, while snow covers the nearby manure. A Cooper's Hawk happens along and catches the covey in midfield. He gets one. Eleven left.

So the covey must give up the manure. Watched by the hawk, it "holes up" all day under the grapes, foodless for 2 days. They all drop from 190 to 170 grams--a large loss in speed and strength.

So the third day they stay right in the marsh where they roosted, and find they can scratch up enough dodder, jewel-wood, and smartwood seed to live. The hawk gives it up and leaves. But now comes a really deep snow, hiding all the marsh food.

They sally forth, forced by hunger, to the locust trees at (H). This is poor food, and uses up nearly as much energy as it gives. The average weight is now 160 grams. One night a wandering mink flushes the roosting birds, which scatter in the dark. One alights in the open, where a horned owl picks him up. Two others die of cold. Eight left, weight 160 grams.

MARCH: A thaw comes and exposes the old manure near the fence. The remnant eagerly resumes feeding there. But the farmer now burns the marsh, forcing the birds to roost under the grape. Here a passer-by flushes them one evening so late the owl scores. Seven left, but weight going up. Many migrant Cooper's Hawks this month, but on the snowless ground with educated birds they fail to score.

APRIL: Green alfalfa and waste corn has picked up weights, and the birds begin to pair on warm days, and look for nesting territories. The unmated cock whistles his disappointment.

Figure 24a: Biography of a Covey

MAY: The three pairs begin nesting, one in the alfalfa, one in the greening marsh, another on the ditch.

JUNE: The haymower gets the alfalfa nest (a), a rain floods the marsh nest (b), but the ditch nest (c) brings off 13 chicks. Total 8 plus 13 = 21.

JULY: Hen (a) tries again in the foncerow, but her incomplete clutch (3 eggs) is abandoned when a stray dog flushes her from the nest. Hen (b) tries again in the oats field, and brings off 11 chicks, of which a cat gets 4. 21 plus 7 = 28.

AUGUST: A marsh hawk, a weasel, and a spermophile each get a chick. 28 - 3 = 25.

SEPTEMBER: Easy going. One chick is hit by a car while crossing the road. Total 24.

OCTOBER: The new covey oats ragweed and foxtail in the cornfield and oat stubble. A pheasant hunter poaches 4. Total 20.

NOVEMBER: Same. A rabbit hunter pots 2. Total 18.

DECEMBER: A Cooper's hawk catches the covey in the open twice, and scores each time. A horned owl gets one. Total on Jan. 1 is 15, same as a year ago.

Figure 24b: Biography of a Covey

860

Map for BIOGRAPHY OF A COVEY

Figure 24c: Biography of a Covey

This biography uses Developing (QA2) criteria for Question and Analysis because it demonstrates how procedures such as weight data were used to gather information about environmental problems that affected the quail through the course of the year. Like the other two biographies, this one demonstrated how data were acquired from observation of the species.

All four levels (KPS1), (KPS2), (KPS3), (KPS4) for the rubric of Knowledge of Processes and Systems are included for this biography. Students were given the identity of local flora and fauna and the description of the life cycle and patterns of quail throughout the year. The connections of reciprocity and feedback were described by the relationship of the quail to predators, roost sites, and food sources. The quail had adapted to the manipulations of the ecosystem by the farmer as the quail depended and migrated around the various actions from farming activities. The example showed how ecosystems operate on various levels.

The four levels (EPS1), (EPS2), (EPS3), (EPS4) for the rubric of Environmental Problem Solving are included for this biography. The example showed how the farmer was connected to the natural environment through the course of the year with agricultural activities. The farmer's relationship to the environment over the course of the year changed according to the seasons and crops. Examples of all the organisms discussed demonstrated ways different organisms adapt to changes. The example of agriculture used was related to the environmental conditions and examples of the farmer's activities were related to the changing seasons.

Data Source 19: Deductions from Biographies and Slide Presentation

Leopold provided students with summaries of the biographies and followed up with a slide program to clarify and demonstrate the details of each biography of the pheasant, great horned owl, and covey of quail. The concepts of mortality, niches, and carrying capacity were introduced, and the slide presentation visually substantiated the biographies so that there was no doubt students would be prepared to recognize the components of each biography when they went on field trips to an outdoor setting.

DEDUCTIONS FROM BIOGRAPHIES

1. A winter niche is habitable to the extent that it offers alternative food and cover combinations, i.e. diverse food and cover.
2. A winter quail covey suffers only slight mortality from weather or predation when it has sufficient food and cover. Such a covey moves only within its usual triangles, and there is relatively secure.
3. When a winter covey is short of food or cover, and must "stretch" its triangles, or seek a new niche on unfamiliar ground, it becomes vulnerable to both weather and predation. Which does the killing is unimportant; one or the other will kill.
4. The worse the weather, the fewer alternatives, the poorer the food and cover, the greater the mortality. In "emergency winters" even the good niches fail, and wholesale mortality occurs, even on fat birds (as in 1935-36).
5. In a given habitat the quail or pheasant population ordinarily surviving normal winters is its carrying capacity, or "threshold of security".
6. Surplus quail above carrying capacity cannot survive because it is evicted (by intolerance) into marginal niches, and there becomes vulnerable.
7. Populations below carrying capacity normally survive with little loss because they have their choice of niches.
8. A predator like horned owl is almost immune to weather and presumably always has food, but when evicted from his home range he is vulnerable, even in summer.
9. Survival in a wide variety of species seems to be an interplay of social intolerance (internal) and environmental contingencies (external).

Comment: There is a widespread coincidence between mortality and movement into unfamiliar terrain. Migrating birds are vulnerable to predation, weather, and accidents. Pheasants released on new range suffer heavier loss than those not moved. Why does a fox, rabbit, cougar, or bobcat, when run by hounds, always "circle" within his home range? Presumably because he is at a disadvantage elsewhere.

We assume here that movement into unfamiliar terrain is the cause of mortality, but it may at times be an effect, or else both may be the effect of some unknown sociological condition.

Figure 25a: Deductions from Biographies

Revised 1947

Lecture 5: Niche, Mortality, and Carrying Capacity

The lectures so far may be summed up as follows:

1. Habitability depends on certain combinations (alternative triangles) of food and cover.
2. These combinations in turn depend on soil and plant succession.
3. Plant succession in turn depends on land-use.

Thus the presence or absence of any given animal, within its geographic range, depends in the last analysis on land-use.

The biographies, which you have now read, now enable us to add:

4. Population level depends on the interplay of land-use with social intolerance, weather, and predation.

Notice that three of these forces are external to the species; one is internal.

(A) Alternative Triangle for Quail

- 720 Marsh-grape-corn. Habitable; no mortality.
- 1368 Quail when roosting are in "rosette" formation.
- 595 Droppings in a marsh roost.
- 1336 Grape loafing cover. Not same as roost cover. Needn't be clear overhead.
- 8-37 Cornshock combination broke down when corn moved.
-
- 724 Marsh-grape-mamure. Habitable. No mortality.
- 516 Mamure spreader.
- 1075 Fencerow used as "street".
- 725 Mamure too far from cover. Not habitable because (1) Mortality by hawk, (2) covey harassed by hawk, hence
- 505 lost weight, became vulnerable. Weight loss and vulnerability develop together. Quail below 4 oz. (5th profile) will freeze in subzero weather.

Figure 25b: Biography Slide Program

and are readily caught by predators (such as redtail) which can't catch fat quail.

723 Marsh-locust-marsh. ~~Not habitable because food low grade.~~

1103 Locust

1825 Eating locust beans on snow. *Helen Johnson* locusts nibbled on food for quail?

Conclusions: will defer till through with pictures.

(B) Alternative Triangles for Pheasant

Much the same as for quail, except that (1) roosting, feeding, and loafing spots may be further apart (2) less dependent on cover for safe travel.

1878 Pheasant trail from marsh roost to soybean stubble.

1987 Pheasants feeding on soybean stubble.

1067 Frozen creek used as a travel lane. (When snow too deep for foot travel, pheasants fly to cover their triangle). *Helen Johnson* what are parallel tracks in lower right corner?

592 Down corn is readily dehusked. *Deeper the snow, the more necessary to dehusk.*

1101 Burdock seeds are threshed out, leaving mats of discarded burs.

737 In very cold weather, pines are often used as roosts.

1947 Pheasants, like quail, become vulnerable, *when hungry, or when very abundant.* Cooper hawk kill, Arboretum.

A winter flock does not defend its home range as a quail covey does, *but we have found that some birds return year after year to same winter range.* hence it isn't a territory. *Bob Kehrman* 14 miles S. from S. to which old hen, not a fox?

362 But in late winter cocks begin to crow. About to appropriate a territory for his (future) harem. These form by April. (Crowing has started. *See Kehrman* Is it a dissemination event at first?)

(C) Horned Owl

1496 3 horned owl territories mapped by Baumgartner. (How? Droppings, kills, and actually watching at night for hoots and fights with adjoining birds). *usually, but the daylight observations.*

Figure 25c: Biography Slide Program

1991 What are the "makings"? Boost for daytime: a pine, grapevine, or leafy oak.

Wingnut Knuspele. Why a leafy oak? Any warmer than a naked one?

1386a An old crow's nest, or hawk nest, or ledge on a cliff.

1858 A thicket for rabbits. Grassy ground for mice.

1727 Biography speaks of a muskrat "wandering cross-country from a distant pond" (from which he was likely evicted by too many rats or too little water. More later of this).

452 Young owls (short ears). (These are of different sizes, and one egg isn't hatched. Harvey Cvent Why not all hatch at once, like chickens?)

1367 Food remnants at a H. O. nest on ledge.

788 Young owl (eared) just after leaving nest. Reckoned here why do young owls suffer heavy mortality just after they grow up?

(D) Loss: gain Equilibrium

X193 The three biographies are hypothetical cases, but based on much research. Here are the three population levels, plotted together on same graph, by months. The spring survival (2 owls, 6 pheasants, 8 quail), if repeated for a series of years, is the CP of that ^aform

1665 How closely does actual survival repeat? Here is an actual case, quail at Prairie du Sac (4500 acres) plotted as breeding gain (solid) and winter loss (dashed). During the early 1930's the spring survivals were about 300. During 1940's about 150. Here we had a ^{drop} change in CP, of which more later. Notice that when gain exceeded loss, trend was upward. When loss exceeded gain, trend was downward. This "sawtooth curve" will be discussed repeatedly. Heard de Gans: If we had a sawtooth curve for human ovls, plotted same scale, would birth be longer or shorter?

1668 Here is the loss history of 12 coveys through the winter of 1941-42.

Stippled zone was a bad storm. Notice that some coveys lost only slightly (good niche) others heavily (submarginal niche). The spring survival in

Figure 25d: Biography Slide Program

end
slides

all niches indicates their "threshold of security".

Here the actual spring population level of H. O. at Prairie du Sac since 1930:

4-6-6-4-7-7-5-6-5-4-8-7-6-7-5-5 (Aver. 5.1) $4500 \div 5 = 900$ acres per owl,

density, ^(15 1/2 sq mi) Very uniform survival. 5 owls is the carrying capacity.

Figure 25e: Biography Slide Program

It was imperative that students understood ecological concepts and recognized these concepts in the field, whether it was on the university campus, at home, or in a park, farm, or research study area. The slide program gave further information for students to be able to look at their environment and evaluate the ecosystem. By using the stories from the biographies and reinforcing the stories with visualization, students would be prepared to take field trips and put the information together so that it could be applied in other case scenarios. The presentation of the biographies through stories, concept definitions, and slide programs encompassed most every category for the levels (QA1), (QA2), (QA3), (QA4), (KPS1), (KPS2), (KPS3), (KPS4), (EPS1), (EPS2), (EPS3), (EPS4), (PCR1), (PCR2), (PCR4) for Rubrics of all Four Strands for Environmental Education with the exception of Accomplished category in Personal and Civic Responsibility. There was no match for this category because it is unclear from the lecture materials if there were opportunities discussed that incorporated acts of environmental stewardship.

Data Source 20: Wildlife Techniques

Leopold discussed the various techniques needed in the field. Leopold used this lecture so that students would be prepared for upcoming field trips (left hand corner indicates upcoming field trips on Thursday, Friday, and Saturday).

Thurs Traps 12
Fri PM 2
Sat AM 12

Sat AM 12

Wetlands
Wildlife Ecology 18

Lecture 14. Wildlife Techniques.

B58

Manuals, Comprehensive ^{Wildlife} Manual is not to be written. There are manuals for some subjects:

Good Manuals for:	none for
Artificial Propagation	Recovery Regime
Banding	Census
Skimming	Traps and Trapping, Micromammals
Identification of Plants in Stomach	Identification of Seeds in Stomach
	Nesting Sites
	Surveys & Maps
	Library Systems

The ecological student of course uses the skills developed in the various biological sciences; also some of the physical sciences (esp. photography). But many of the biological skills need to be extended and refined: viz. sexing & aging.

(A) Census, Trapping, Banding

For comprehensive treatment see Chap. VI, Game Management. I have given only some selected fragments of current work. This is as short as well as science.

I want you to have a realistic picture of what this means.

Arboretum Phacelia

X-18. Scheme of Drives conducted ^{each winter} since 1935. Notice birds are pushed backward. Why winter? Because couldn't drive the marshes without doing so. Strongy Creek - showing line formation.

(Also over micrograph)

Sat 12

Figure 26. Wildlife Technique

The lecture meets the rubric for Developing (QA2) criteria under Question and Analysis. Students were introduced to procedures so they could gather information for environmental problems.

Data Source 21: Animal Populations

Leopold used deer and quail studies to introduce population variances and seasonal behaviors. These examples identified the local wildlife problems when variables changed, causing fluctuations in cycles that could lead animal populations to swell, shrink, or, in some instances, to become extinct.

Wildlife Ecology 118
Aldo Leopold

POPULATION MECHANISMS OF DEER AND QUAIL

Character	Deer	Quail
1. Winter food habits	Eat mainly <u>twigs and reproduction</u>	Eat mainly <u>seeds</u>
2. Ratio of summer to winter range	Only part of summer range habitable in winter, hence both species must concentrate	
3. Responses to crowding		
Internal pressure	<u>Stay put. No intolerance of deer for deer</u>	<u>Disperse to marginal locations. High intolerance of covey for covey.</u>
Food Plants	<u>Weakened by overbrowsing; replaced by non-palatable plants.</u>	<u>Not affected. Replacement occurs only by plant succession.</u>
Predation	<u>Original predators probably dispersed concentrations. Present predators get only starving deer. Loss depends on kind and number of predators.</u>	<u>Predation loss not affected by kind or number of predators. Only marginal coveys are vulnerable. Sum of food ranges thus constitutes a "threshold of security", below which only nominal loss occurs.</u>
Physical deterioration	<u>Antlers and weights stunted by malnutrition</u>	<u>Stunting does not persist; bird dies or thrives.</u>
4. Responses to human activity	<u>Logging (down tops) feeds deer, but is not dependable. Artificial feeding is expensive. It prolongs and intensifies damage to natural foods.</u>	<u>Artificial feeding not expensive. Does not affect natural foods</u>
5. Reproductive success	<u>Rate of gain apparently not affected by density of breeding stock. Population not self-limiting.</u>	<u>Rate of gain inverse to density of breeding stock. Population is self-limiting.</u>

1943

Figure 27a. Populations

DARLING'S THEORY OF
MINIMUM POPULATION

How survival is influenced by spread of breeding dates in a colony of gulls. (From Darling, "Bird Flocks and the Breeding Cycle," 1938, p. 70.)

Extinct species believed to conform to the Darling theory:

Passenger Pigeon
Hoath Hen

Rare species probably not recovering from low population levels:

Grizzly Bear
Bighorn
Condor
Ivorybill Woodpecker
Whooping Crane

Species surviving at low population levels:

Wolf
Otter
Fisher
Marten
Desert Sheep
Kirtland Warbler
Trumpeter Swan
Spruce Hen
Wild Turkey
~~Swainson's Warbler~~
~~Swainson's Warbler~~
~~Swainson's Warbler~~
Duck Hawk
Gull-billed Tern

Species recovering from low population levels:

Beaver
Door (in many states)
Black Bear
Antelope
Wood Duck
Upland Plover
American Egret

Figure 27b. Populations

These lessons meet the criteria for Knowledge of Processes and Systems for all four levels (KPS1), (KPS2), (KPS3), (KPS4). Deer and quail were identified along with their patterns of behavior affected by the various environmental conditions. Broader applications of population mechanisms were shown through examples of other species and the Darling theory on minimum populations.

Data Source 22: Population Census

Leopold assembled data from wildlife populations from various field studies in the Wisconsin area to share with students. These studies gave snapshots of population dynamics and shifts for individual species over a period of time. The data complemented the phenology studies when compared to the environmental factors that constantly

changed.

Figure 28a. Population Census

Figure 28b. Population Census

The lessons matched the criteria for Beginning (KPS1) and Developing (KPS2) under Knowledge of Processes and Systems. The data showed how life cycles varied among species over the years. This helped build assumptions for understanding the balance between predator and prey relationships.

Data Source 23: Weight Ratios

To demonstrate the relationships of yield and carrying capacity for an area, Leopold introduced pyramid concepts by giving data to students that showed a specific location where the number and type of species had been identified. Each species had been weighed and a combined total weight given. With this information, Leopold showed the potential wildlife population that a designated geographic area could support.

3200

PILE STRAND OF KIMBERLY AND WEIGHTS
PRAIRIE IN SAN ANTONIO - COLUMBIA COUNTY - TEXAS

Figure 29a. Numbers and Weights

1024

227

This lesson was an example of wildlife techniques for gathering information to solve environmental problems; it matched criteria for Developing (QA2) under Question and Analysis. This lesson matched criteria for Accomplished (KPS3) under Knowledge of Processes and Systems by comparing numbers of animal species and their weights to a particular geographic location.

Data Source 24: Range

Leopold wrapped up these series of lessons on wildlife populations by introducing the relationship of animals to their range or boundaries. Using examples of species such as deer, rabbits, ducks, wild turkey, etc., Leopold illustrated that range depends on various factors and cannot be generalized. Some of the tendencies that may shift range could include food, temperature, natural catastrophe, or human intervention.

show on either Anthony's for three reasons: his map is of the whole US, and the convolutions were not known, the boundary has changed.

Dynamics of Range

(A) Shrinking & Expanding Boundaries

Boundaries are never static, although most books imply they are. Snowshoe range is shrinking. How do we know? Historical record of "white rabbits" in Sauk, Richland, Buffalo, and possibly Dane. The present outliers are relic colonies. Former relics, now extinguished, show here as "date last seen" when the date is known.

1891 ~~1896~~ Deer and Snowshoe. Deer are expanding. How do we know? In 1924, when I came to Madison, there were no deer on Wisconsin River below Okees. Stray deer now show up almost yearly in many southern Wisconsin counties.

In general, how does one distinguish a relic from an outpost; a shrinking from an expanding boundary? If a species is growing scarcer, or hunting poorer, or seasons shorter, or occurring in fewer localities, there is a presumption of shrinkage. But if a species is appearing in new localities where it was not previously seen, there is a presumption of expansion.

1450 1977a Jackrabbit. Here is an expanding species. There is a clear eastward progression of arrival dates; the boundary is expanding east and north. The main boundary is where former outposts have coalesced. When Cory wrote his book (1912) jackrabbit was not listed; he did not know it existed in Wisconsin. It was then very scarce, and occurred only in a few western counties. Cause of expansion? Probably "clean farming", simulating short-grass prairie.

X6 Hungarian Partridge. 1937. Another expanding range. Spread from original planting in Waukesha County by decades. Show where impinged

Figure 30a. Range

on sandy soils, Columbia Co. and stopped. A 1940 map by McCabe shows the sound was a real obstacle.

Pulsating Boundaries (Alternate spread & shrinkage)

~~1879~~ Wild Turkey. Looks like a simple line from Prairie du Chien to Green Bay, but careful dating shows N. and S. pulsation.

In 1840: N. line Prairie du Chien to Milwaukee. N.E. stations all French (1600s) or prehistory (see cross, Indian Midden on L. Winneconne). Cause of pulsation?

Probably recession in hard winters, followed by re-expansion.

1674-75, Marquette: "Turkeys (near Milwaukee) almost dying of hunger, deer so lean as to be unfit for food."

1842-43, Kumlien: Winter of 1842 had fatal snow 2' deep in March, stout crust, turkeys "Became so poor and weak they could not fly -- exterminated almost entire race."

Instance of advance between hard winters:

1852, Rock Co. turkeys "in droves" came in from Illinois. (See Schorger, Wilson Bull., 54(3):180)

What Sets Range Boundaries?

A case of boundary set by soil (Hungarian Partridge in Wis.) has already been mentioned; also a quail boundary set by food, and a deer boundary by cover.

2023

Ducks. Most species breed mainly on sedimentary rocks of western B.w.teal Canada. Fact well known, reason little known. Greater fertility of soils from these rocks affects aquatic foods, perhaps especially those needed by ducklings. Reason is not water, for there is even more water on the almost-duckless pre-cambrian rocks to the eastward and northward.

Figure 30b. Range

416 ~~1512~~ Wild Turkey in Mo. 79% of 1943 population on "Clarksville stony loam", characterized by "balds" (small prairies). Clarksville gravelly loam, similar but without balds, supports only 15% and these declining. Reason? Open places for young to dry out in wet spells? (See A. S. Leopold and Dalke Jour. Forestry, 41(6):428-435, June 1943, see p.432.)

2013 ~~1516~~ Bobolink

call ~~X117~~ Antarctic Sea Birds. Man-of-war bird limited to warm currents, antarctic tern to cold currents in S.A. (Murphy, Oceanic Birds of SA, Vol. 1, p.165). Here water temperature is the boundary.

end slides

Mechanics of Spread

Shrinkage occurs where losses exceed gains for too long a period.

Spread. Three propulsive forces lie behind most instances of spread (diagram)

1. Seasonal innate restlessness occurs regardless of food supply.

a) Summer movements of young animals once they become independent of their parents.

b) Post-breeding season movements of entire populations

1. Fall shuffle of bobwhite quail.

2. Southern herons typically move N. Reasons not clear.

2. Social intolerance (expulsion of individuals or groups by social pressure) may of course be tied in with food supplies.

o.g. "Runner" Muskrats. Each spring and fall, and sometimes in winter, wandering rats set off cross-country. They often have wounds, indicating fights, but sometimes they are evicted by very high or low water. This ~~is~~ spread is so reliable that if you build a new pond you needn't stock it with rats; runners will appear. Runners come up the campus storm sewers every year; last year I recorded them April 1 and April 7. Dead muskrats on highways are runners.

Figure 30c. Range

A17

Many cases are reported where squirrels persisted in numbers without intolerance but with an abundance of food.

Ohio 1817 50-60 dashing out of fields of grain

Pa. 1798 running by the hundreds in all directions

3. Eviction by starvation or other catastrophe

(a) Experimental Data

Wold and Jackson have shown that nutritional deprivation in laboratory rats stimulates activity in the form of running (1944: Proc. Nat. Acad. Sci. 30(no.9)p.262)

(b) Examples

*This was during a
low on the hare
cycle*

(1) Individual Stragglers

"Stray" Carnivores. In 1946 a lynx was killed at Spring Green, 1 county west. Must have travelled 300 miles. Last year a timber wolf was killed in Grant Co.: 200 miles. [Coyotes occur every year in agric. counties without regular populations. These are presumably expulsions by social pressure. Most carnivores are very tolerant.] An Arctic fox on L. Winnebago in 1951-52, was a stray — but not necessarily in Wis. for ecological reasons!

(2) Mass Emigrations.

1". In Wis. these have been found to be often simultaneous for bears, gray squirrels, and even turkeys. The mass exodus of squirrels has been frequently reported from many parts of N.A., Europe and Asia, distances up to 200 miles being ~~corded~~ reported. [Read AWS re 1878 (see next pages)]

2". In the hard winter of 1935-36, Hungarian Partridges moved en masse into Sheboygan and Manitowoc Counties, where they "took". They moved from the populated range to the south (diagram). Starvation was probably the propulsive force (Leopold: Spread of the Hun. Part. in Wis. Acad. 32(5-28, see p.15). A similar movement was evident in this same region in the ~~the~~ winter of 1950-51 ^{hard}

Figure 30d. Range

3". Pallas's sand-grouse invaded Britain and bred

1859 99 1908-9

63 1904

88-91 1906

(3) Slow spread | a) Changes in climate
| b) Regional changes in life form of vegetation | deforestation
Deer, cardinal, moose, etc. | reforestation
| irrigation

Sex Invasion. Prof. Wm. Rowan of the Univ. of Alberta tells me (unpubl.)
that pheasants moved en masse into his province, probably in the early 1940s.
Males preceded females. Cause entirely unknown.

General

What limits a species on one boundary of its range does not necessarily
hold for another. Thus temperature might limit your ability to colonize
Saskatchewan, but in Dakota it might be water, in Kansas wind, in Louisiana
mosquitoes, and in Georgia hookworm. No one limitation ever surrounds an
entire range (diagram). Every range is bounded by several barriers or
limits. *Pheasant is limited to the south by high temp. few feathers results*

Grinnell points out that if animals were free to spread, all species
boundaries would be perfect circles. No such boundary in nature.

Grinnell says (Presence and Absence of Animals, "Univ. Calif. Chronicle,
Oct. 1928, p.433): "Animal species do not wander about....rather they....
move.... only as they are forced to do so... as they are directed by changing
conditions....Animal populations are....herded about."

We must conceive of these changes as operative not only on the periphery
of a range, but all over it. Indeed most ranges consist of thousands of
"islands" each of which is expanding or shrinking.

In the course of geologic time these gains and losses display trends of
large magnitude. Thus the passenger pigeon, in 1800s bounded on W. by the

Figure 30c. Range

great plains, but once occurred in Calif., for its bones are found at Rancho, La Brea, Calif. (Reference: McClanahan, Robert C. Original and present breeding ranges of certain game birds in the U.S. USBS Wildlife Leaflet BS-158 April 1940.)

Is spread due to expanding population or instability?

Figure 30f. Range

Criteria for Developing (KPS2) and Accomplished (KPS3) are matched for Knowledge of Processes and Systems in this datum. First, living organisms are regulated by their life cycle and its response to environmental conditions. Second, Leopold discussed how animals extend their range and, in some cases, abandon their range, due to various connections of reciprocity and feedback with the environment. Large groups of species, such as "runner muskrats" or squirrels, have been known to move long distances. Stray species are sometimes observed, out of normal ranges for their species, such as a lynx or coyote. All cases are limited by various factors such as food, environmental fluctuations, human interventions, etc.

Data Source 25: Food Chain Definitions

Leopold used this sheet of definitions to describe the different relationships between organisms. As with most other examples, he always included the human relationship to the environment: In this case, Leopold demonstrated the symbiotic ties of people to economics.

Definitions of Food Chain Relationships

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Exploitation

The upper member consumes the products of the lower, but without ordinarily killing it. Thus plant-eating animals consume the leaves, stems, fruits, or buds of the plant and the plant grows new ones. Over-exploitation, of course, may kill the individual plant or even wipe out the species locally.

Predation

The upper member kills and consumes the individual lower member, but ordinarily without wiping out the species. Hunting is a form of predation.

Predation and exploitation occasionally operate jointly to form the link between two species: thus the farmer exploits the cow for milk, preys on her product, the calf, and ultimately preys on the cow herself.

Interpredation: two species which prey on each other, as the owl and the crow. Such cases are not uncommon, but they are usually highly conditioned; thus the crow is vulnerable only at night; the owl only as an egg, or when attacked by a mob of crows with no cover to hide in.

Services (relationships not involving food)

Symbiosis: An exchange of services for which each member is dependent on the other. Thus alfalfa "houses" the nitrogen-fixing bacterium in a nodule grown for the purpose; the bacterium fixes nitrogen from the air for the alfalfa, and thus eventually for the soil and the rest of the biota. ~~Exploitation: the rabbit buffers the mouse against predators; the mouse checks houses the rabbit against both predators and weather.~~

Cropping Symbiosis: An exchange between a farmer and a race of plants or animals. The farmer preys on the individual but renews and protects the race (viz; all annual crops and most livestock.)

Human Symbiosis: The inter-human exchanges of labor, goods, and advice, usually operating through the common denominator of money, are, of course, an elaboration of symbiosis.

Buffer Service: ^{former} An animal stands between prey and predator, with the effect of shielding the latter. Thus the mouse buffers the quail from the fox because the mouse is easier to catch. At times buffer service may be reversed: in deep snow the mouse is housed in a mighty fortress, while the quail is vulnerable.

Parasitism

An exploitation in which the upper member (parasite) resides in or on the lower member (or host) and consumes his products (or food, or tissues) without killing. Example: tapeworm in rabbit or flea on rabbit.

Disease: A maladjusted parasitism in which the parasite becomes lethal to his host, and thus lethal to himself (as an individual, but not necessarily as a race.)

Vector: An animal which transmits disease between two other animals without itself being affected. Example: tick transmits tularemia from one rabbit to another, or from rabbit to grouse.

Conditioning

A limitation on the effectiveness of a link in a food-chain, ^{in part or time}. Thus:
Fox preys on quail.....in winter when mice scarce, or as juveniles
Dog preys on rabbit.....as juveniles, or in deep snow, with warm weather.
Alfalfa exploits soil.....when alkaline and inoculated
Ragweed exploits soil.....when competing sod is broken
Mouse buffers quail,.....except in deep snow
Tularemia paralyzes rabbit.....when tick (vector) transmits it

*Exploitation usually present in lower links
of a food chain.*

Figure 31: Definitions

The lesson plan matched the Developing (KPS2) and Accomplished (KPS3) criteria for Knowledge of Processes and Systems. The terms are used to identify the patterns of living organisms with each other and showed the connections of reciprocity and feedback through food chains.

Data Source 26: Food Chain Diagrams

Leopold introduced a series of food chain diagrams that depicted different ways living things are connected to the ecosystem. The first food chain illustrated some simple, direct ties of organisms to each other with the student included. Another was a phenology food chain that showed the life cycle of a deer and the food relationships based upon the seasonal changes. An agricultural food chain depicted the agricultural connections of people to their environment. This food chain was used to connect back to the Case History of the Prairie Coulee. The forest food chain was connected to the Case History of Northern Wisconsin and the marsh food chain was connected to the Case History of a Tussock Marsh.

FOOD CHAINS

Wildlife Ecology 118

Figure 32a. Student Food Chain

(F) CALCIUM-PHOSPHORUS CHAIN
FOR RED DEER
 After F. Fraser Darling:
 "A Herd of Red Deer" 1937
 "A Naturalist on Rona" 1939

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Phenology

Figure 32b. Phenology Food Chain

(B) AGRICULTURAL FOOD CHAIN
 Southwest Wisconsin
 (See Case 2, Prairie Coulees)

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Figure 32c. Farm Food Chain

Figure 32d. Forest Food Chain

(B) FOOD CHAIN OF A S. WISCONSIN MARSH
Before and After Drainage
(See Case 7, History of a Tussock Marsh)

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Figure 32e. Marsh Food Chain

These examples of food chains matched all four levels (KPS1), (KPS2), (KPS3), (KPS4) for Knowledge of Processes and Systems. Organisms are identified and examined through their relationships with each other. Connections are shown to demonstrate how feedback and reciprocity take place. The details of the relationships and levels and ties between organisms demonstrated how ecosystems operated.

Environmental Problem Solving is depicted on all four levels (EPS1), (EPS2), (EPS3), (EPS4). Humans ties are illustrated and the cultural contexts in the Farm Food Chain and the Student Food Chain. These relationships showed the farmer ties with the land, the county agent ties with the farmer, the erosion engineer ties with the farmer, and the bureau chief's decisions that impact the county agent, farmer, and erosion engineer.

These decisions, in turn, affect the ecology of the area. In the Student Food Chain example, a student became a lawyer who bought food from the grocer who bought food from the farmer. The farmer was also connected to the mechanic who made the equipment that the farmer used and the mechanic was controlled by the type of equipment made by the union boss. Leopold illustrated the complicated cultural contexts to show how environmental conditions could be affected.

Data Source 27: Deer Problems

At the end of the course, Leopold spent the last series of lectures on cases of current environmental studies for that time period. In these data, Leopold used deer populations and the various examples of cases across the United States that faced deer overpopulation because predators had been eliminated.

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January 21, 1943

Wisconsin Deer Committee

Outline of the Deer Problem

1. Many other states have faced the problem (Oregon, California, Utah, Ariz., New Mex., Colo., Texas, Pa., N. Y., Mass., Conn., N. H., N. C., Ga.)
2. All follow same sequence: local damage spots, widespread damage spots, starvation, deterioration of herd. In severe cases, the herd loses capacity to recover its numbers even after food recovers. (Kaibab)
3. No state has so far taken decisive remedial measures before deer and range are damaged, despite 5 years' warning in some cases.
4. Problem arises from those characters of deer and deer food plants:
 - (a) Deer, unlike other game, starve rather than move. Hence starvation is always spotty.
 - (b) Over use by deer eventually kills their winter food plants. Over use by game birds does not kill their winter food plants.
 - (c) On over used range, over used valuable plants are eventually crowded out by unused worthless plants, either directly by browsing of the valuable plants, or indirectly by browsing of their reproduction. This gives worthless plants a competitive advantage.
 - (d) Artificial feeding of deer intensifies a, b, and c. Artificial feeding of birds carries no known penalties.
 - (e) Malnutrition reduces weight and antlers, but not rate of reproduction. It is alleged to distort sex ratio, but this is not proved. Malnutrition increases diseases, parasites, and predation. It kills young deer first.
5. There are no records of excess deer previous to the beginnings of organized predator control (1910), nor previous to organized refuges combined with buck laws (Pa., about 1915).
6. There are no American records of excess deer where these measures are absent, even on good deer range (Mexico).
7. The deer problem has been extreme in parts of Europe, where predator-control is extreme, but buck laws and refuges are absent (Germany, Scotland).

Figure 33a. Deer Population

EFFECT OF PROMPT VS. DELAYED REMOVALS ON CARRYING CAPACITY FOR DEER

Herd A is enclosed, and has no predators. The area was stocked in March, 1928 with 2 bucks and 4 does. Between 1928 and 1933 it increased at the full potential rate. The 1933 census showed 49 bucks, 49 does, 69 fawns. Since 1933 the herd has been held at 75.

$75 = 1 \text{ deer per } 16 \text{ acres}$

Removals			
← 600	→ 74	← 142	→ Cougars
← 30	→		Wolves
← 3,000	→ 4388		Coyotes
← 17,844	→ 9372		Deer

Herd B is "enclosed" by deserts and the Grand Canyon. The census points are estimates. The carrying capacity in 1939 was half that of 1910 when the herd was of the same size (about 10,000).

Figure 33b. Deer Population

Figure 33c. Deer Population

These data matched four levels (KPS1), (KPS2), (KPS3), (KPS4), (EPS1), (EPS2), (EPS3), (EPS4) for both Knowledge of Processes and Systems and Environmental Problem Solving. For Knowledge of Processes and Systems, Leopold

identified the factors that influenced the life cycles and patterns of deer behavior and how deer reacted to the various feedbacks in the ecosystem as various elements, such as over-hunting or removal of predators, affected the deer population.

For Environmental Problem Solving, deer populations were compared between states over periods of decades. These comparisons showed how human interventions resulted in various factors that caused deer populations to decline and excel. The problem illustrated how cultural contexts, such as the change from wilderness to agricultural setting, caused immense devastations in local ecosystems.

Data Source 28: Factors of Population Fluctuations

To summarize factors that influenced all wildlife populations, census charts were used to compare the various ranges. The breeding potential of wildlife species depended upon the “decimating” factors—those which killed species directly—versus the habitat diversity. If habitat was supportive and abundant, decimating factors were less aggressive on a given population.

Classification of Factors

3/9 11/22

Equation. Population = breeding potential - (decimating factors - welfare factors)
Net for all species Decimating factors (which kill directly): hunting, predators, starvation, disease (incl. parasites), accidents (mechanical injuries).

Welfare factors (which retard decimation): food, cover, water, special factors

Examples of Special Factors
(Specialised kinds of food and cover)

Gravel	For gallinaceous birds, ducks and geese, shorebirds
Salt	For ungulates, doves and pigeons, grosbeaks, porcupines
Dust baths	For nearly all birds
Mud baths	For bear, ungulates
Hibernation cavities	For bear, marmots, gophers, skunks
Nesting cavities or place to excavate them	For woodpeckers, flycatchers, squirrels, swallows, owls, kingfishers, wood ducks, carnivores <i>& Lava flows in Arizona</i>
Caves	For shading and lambing of mountain sheep. Bat roosts, cat dens
Wind-swept places	For escape from insects. Ungulates.
Porchos	For hunting or watching by kingfisher, heron, eagle, vulture
Waterfalls	For ouzel nests
Loafing bars	Gulls, terns, geese
Boom and dance grounds	For mating displays by ruffed grouse, prairie chicken, sharp-tail, woodcock
High altitude	For escape from insects, red deer in Scotland. Caribou in Labrador?

Influences

(Environmental conditions which influence the weight of a factor. A given condition may benefit one species and injure another.)

<u>Influence</u>	<u>Benefit to</u>	<u>Injury to</u>
<u>Weather</u>		
deep snow	mouse, bear	quail
food	duck, shorebird	rabbit
thaw (of crusted snow)	wolf	deer
<u>Drainage (of a marsh)</u>	pheasant	duck
	cottontail	muskrat
<u>Timber cutting (large, clean cut)</u>	redheaded woodpecker	pileated woodpecker
	deer	moose
<u>Fire (in a marsh)</u>	Brewer's blackbird	redwing blackbird
(in peat, inducing aspen)	beaver	sandhill crane
(in brush)	deer mouse	meadow mouse
<u>Cultivation (in brush)</u>	quail, pheasant	ruffed grouse
(in woods)	deer	moose
<u>Grazing (of a marsh)</u>	jacksnipe	jumping mouse
(of a woodlot)	robin	ovenbird

Figure 34a. Population Factors

Figure 34b. Population Factors

Figure 85 met Accomplished (KPS3) criteria for Knowledge of Processes and Systems, as it examined the connections of reciprocity and feedback among various species as conditions that affected behavior were changed. Leopold showed how different food and cover could benefit a particular species of bats when there were roosting areas such as caves available. This figure met Accomplished (EPS3) criteria for Environmental Problem Solving because examples are given of environmental conditions, often created by cultural contexts, are at the advantage and disadvantage for different species. The cultivation of brush piles helps quail populations but eliminates the necessary grasses and low bearing shrubs that support ruff grouse and moose populations.

Figure 86 met criteria for Accomplished (KPS3) and Mastery (KPS4) for Knowledge of Processes and Systems. When breeding dates for gull populations were in

Leopold used examples from Arizona, Canada, Germany, and Wisconsin to discuss how ecosystems function on a broader level. He provided a timeline of wildlife management and made a chart that listed the various species that represented different levels of succession according to the type of ecosystem from which it was found. In lecture notes, there was a discussion of German wildlife history, followed by a comparison of human impact on wildlife systems between Arizona and England.

Figure 35a. Ecosystems

ECOL. OF GERMANY, ex BOHEMIA

ORIGINAL TYPES	CHANGED TO	B ² 30
Sea Coast (sand plains)		
Scotch pine (Kiefer)		
Heaths (the largest type)	planted to pine	
Salix (better soils)		
Oak-beech	replanted to spruce	
Mts (mt. soils)		
Spruce-fir		

Tauna

Red deer inhabits both spruce + oak-beech (equivalent to our elk)

Ree-beech can live in hayfields ^{old} & in forest.

Elch (corresponds to our moose) now restricted to swampy E. Prussia + Baltic regions. % drainage of ~~area~~ ^{swamp}.

Wild horse persisted to 1450, once the principal food of ancient Germans even more so than deer. The Caucasian wild horse has been imported to one German Park.

Beison (Wissent) under fence & artificialized since first war. Polish wild herd ext'd by Red soldiers for food. Wissent now crossed with buffalo and being selected. Chamois (Gemsbuck) holding own except for skiers.

E. Hare (same to Jack rabbit) lives in forest to a

Figure 35b. Ecosystems

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Fallow deer (hunted by Robin Hood) was imported
by 1600

Bustard (Der Trappe) equiv to wild turkey but
inhabits plains; well preserved by Germans
even 10 mi from Berlin.

Eur. Horned Owl once virtually extinct (1925). Now
raised on a game farm & being reintroduced
in Natl forests.

Grbes, herons, swans etc all rare in Germany & persecution of fish-eating birds in course of fish conservation.

Every war in Eur. has caused a decline in game

The invention of factory wire did much to help Europeans perpetuate their ideas of artificial game management

Figure 35c. Ecosystems

Effects of human occupancy

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	<u>Arizona</u>	<u>England</u>
<u>Soil</u>	erosion	no change
<u>conversion of Plants</u>	grass to weeds	forest to grass
<u>Animals</u>	no predators rodents a pest deer irruptions	no predators rodents a pest deer irruptions
<u>Similar cases</u>	Mediterranean Asia Minor Caucasus Central Asia	New England Japan Pacific NW
<u>Basic reason</u>	Bunch grasses? Andropogon etc	Stoloniferous grasses Poa etc
<u>Period of occu- pancy</u>	200 yrs in Ariz	2000 yrs in England

Hypothesis for origin of erosion in Ariz.

Grazing or cutting stoloniferous grasses causes them to send
out runners; bunch grasses do not

Figure 35d. Ecosystems

The lecture matched the four levels (EPS1), (EPS2), (EPS3), (EPS4) for Environmental Problem Solving. Leopold developed a timeline of activities that compared various cultures in Asia, Britain, Germany, North America, and Wisconsin and the succession of wildlife management activities that occurred over time. He used specific examples from Germany that demonstrated past activities that decimated wildlife populations and the current attempts toward game management. Lastly, he compared human impacts on ecological areas of Arizona and England and then related these examples to similar cases around the world.

Data Source 30: Motives for Conservation, Closing Lecture

Leopold used examples of cultural taboos in human history to appeal for a human ideal that strives for a relationship with the ecological community. A new ethic is needed that places human behavior and actions within the realm of a cooperative relationship with the land.

MOTIVES FOR CONSERVATION

The whole content of the conservation idea may be expressed thus:

1. Build up the soil
2. Retain a diverse flora by keeping at least a sample of each stage of each plant association.
3. This will automatically retain a diverse fauna.

The value of such a program depends on widespread distribution, i.e., on private as well as public practice. Conservation cannot be relegated to public reservations any more than virtue can be relegated to Sundays or beauty to art museums.

What is the probability of such a program?

(A) Economics

The whole trend of economic land-use is toward monotypes, i.e., *it is* the antithesis of diversity in landscape. Thus:

1. Machines operate best on large uniform sweeps. Machines breed specialists in farm as well as factory.
2. The momentum of pioneering is toward monotypes. It was good to subjugate some of the land; therefore it must be better to subjugate all of it. "Clean farming".
3. Public conservation breeds monotypes (public forests, parks, etc.).
4. Pooling of faunas and floras breeds monotypes. Pheasant vs. all native game and all predators. Pests reduce natural diversity of flora (chestnut blight, bur oak) and fauna (starling, carp).

We can't reverse these trends, and some of them we wouldn't want to.

The job is to modify them, to synthesize the best in them with the best ~~of~~ the opposing ecological idea. All progress is the synthesis of such opposing pulls. Goethe has pointed out that such synthesis is no mere compromise; it ^{may produce something better than either; it} is the actual essence of wisdom.

But to start such a synthesis we must first put some force behind the

Figure 36a: Closing Lecture

ecological idea; we must create a pull, a motive. What motive?

Profit Motive. Profit in the ordinary sense will move a few, but only a few, of the things to be done. Thus:

Examples

Prance Coulee

1. Soil building is profitable if the soil is still there. If already partly wrecked, it pays to abandon and buy elsewhere. But abandoned land often continues to deteriorate, so government buys it or repairs it. So individual profit collides with public interest. *Profit motive can prevent but not cure.*

Wis. cutovers

*vs
selective logging*

2. Forestry is profitable if there is still a forest; seldom if the forest is spoiled; rarely if both the forest and the soil are spoiled. Again individual profit collides with public interest.

3. Animals. There is no profit for the individual in animal conservation. There may be "pin-money" (fur marsh). Even such pin-money is usually earned by conserving one class of animals at the expense of another (game farms and fish hatcheries vs. predators). But no one doubts that it is profitable for the community to keep its animal life. In the case of predators, the individual may even have to take a loss (poultry, game) to help earn the profit for the community.

4. Non-commercial plants (wildflowers, scenery). No possible profit for the individual; much for the community.

*reflections
rare species
wildflowers
ungrazed woods
marsh*

Viewing the field as a whole, we see one common denominator: regard for community welfare is the keystone to conservation. Private land is only a stock certificate in a common biota. Private land-use must recognize an obligation to community welfare. No other motive has enough coverage to suffice.

Figure 36b: Closing Lecture

(B) Ethics

Land economics then leads us into land ethics. How shall a land ethic evolve?

The history of ethics is an ecological phenomenon. The relations of the food chain (predation, exploitation, parasitism) prevented the full development of the individual. Hence we evolved:

Ethic No. 1. A symbiosis between man and man. This did not "repeal" our animal nature, it was superimposed on it.

Ethic No. 2. A symbiosis between one human community and another. Still very incomplete, as we can judge from events abroad.

Ethic No. 3. A symbiosis between man and land. We cease a predatory relation to soil, plants, and animals, and superimpose the idea of live and let live, a mutuality in welfare. Ecology is simply the factual basis for a land ethic; it reveals why an ethical relationship would make better men and better land.

All ethics begin with taboos. Thus the Mosaic law was a system of "Thou shalt nots" for the man-man symbiosis. Our taboo laws (as game laws) represent the same stage of the man-land symbiosis.

All ethics next achieve a monastic stage, i.e., a stage when the rank and file cannot yet be ethical, but they dimly wish somebody to be, so they set up protected places where ethics can live; they delegate specialists to keep ethics alive, and support them at public expense. Our parks and sanctuaries are the monastic stage of the land-ethic. As in the monastery, the park is the keeper of the taboos. The park is an offset to the pollution and exploitations, the billboards and the defacements of the hurly-burly world.

Resources during the taboo stage and the monastic stage are property, i.e., a man owns them but has no obligations to them. Thus human beings were once property, just as land now is. I quote from "The Conservation Ethic" (Jour. Forestry, 31(6), pp. 634-643:

Family, since the time when man was not content to delegate their ethics to specialists; when they realize that with everybody he comes ethical to some degree, the community belief of ethics is not as dogmatic.

*for community economics
in ethics, 3*

There came a time in human history

man is not the owner of land; he becomes a usufruct

Figure 36c: Closing Lecture

"When god-like Odysseus returned from the wars in Troy, he hanged all on one rope some dozen slave-girls of his household whom he suspected of misbehavior during his absence.

This hanging involved no question of propriety, much less of justice. The girls were property. The disposal of property was then, as now, a matter of expediency, ^(profit) not of right and wrong.

Criteria of right and wrong were not lacking from Odysseus' Greece: witness the fidelity of his wife through the long years before at last his black-prowed galleys clove the wine-dark seas for home. The ethical structure of that day covered wives, but had not yet been extended to human chattels. During the three thousand years which have since elapsed, ethical criteria have been extended to many fields of conduct, with corresponding shrinkages in those judged by expediency only.

This extension of ethics, so far studied only by philosophers, is actually a process in ecological evolution. Its sequences may be described in biological as well as philosophical terms. An ethic, biologically, is a limitation on freedom of action in the struggle for existence. An ethic, philosophically, is a differentiation of social from anti-social conduct. These are two definitions of one thing. The thing has its origin in the tendency of interdependent individuals or societies to evolve modes of cooperation. The biologist calls these symbioses. Man^X elaborated certain advanced symbioses called politics and economics. Like their simpler biological antecedents, they enable individuals or groups to exploit each other in an orderly way. Their first yardstick was expediency.

The complexity of cooperative mechanisms increased with population density, and with the efficiency of tools. It was simpler, for example, to define the anti-social uses of sticks and stones in the days of the mastodons

than of bullets ^{bombs} and billboards in the age of motors.

At a certain stage of complexity, the human community found expediency-yardsticks no longer sufficient. One by one it has evolved and superimposed upon them a set of ethical yardsticks. The first ethics dealt with the relationship between individuals. The Mosaic Decalogue is an example. Later accretions dealt with the relationship between the individual and society. Christianity tries to integrate the ^{individual & society; democracy tries to} integrate social organization to the individual.

There is as yet no ethic dealing with man's relationship to land and to the non-human animals and plants which grow upon it. Land, like Odysseus' slave-girls, is still property. The land-relation is still strictly economic, entailing privileges but no obligations.

The extension of ethics to this third element in human environment is, if we read evolution correctly, an ecological possibility. It is the third step in a sequence. The first two have already been taken. ^(implied) Civilized man exhibits in his own mind evidence that the third is needed. ~~For example, his sense of right and wrong may be aroused quite as strongly by the desecration of a nearby woodlot as by a famine in China, a near pogrom in Germany, or the murder of the slave-girls in ancient Greece.~~ Individual thinkers since the days of Ezekiel and Isaiah have asserted that the despoliation of land is not only inexpedient but wrong. Society, however, has not yet affirmed this belief. I regard the present conservation movement as the embryo of such an affirmation. ~~I here discuss why this is, or should be, so.~~

Some scientists will dismiss this matter forthwith, on the ground that ecology has no relation to right and wrong. To such I reply that science, if not philosophy, should by now have made us cautious about dismissals. An ethic may be regarded as a mode of guidance for meeting ecological

Figure 36e: Closing Lecture

situations so new or intricate, or involving such deferred reactions, that the path of social expediency is not discernible to the average individual. Animal instincts are just this. Ethics are possibly a kind of advanced social instinct in-the-making.

Whatever the merits of this analogy, no ecologist can deny that our land-relation involves penalties and rewards which the individual does not see, and needs modes of guidance which do not yet exist. Call these what you will, science cannot escape its part in forming them."

I quote, in closing this course, Robinson's admonition to Tristram, who saw a fair world, but could not see it was his job to keep it so:

"Whether you will or not,

You are a king, Tristram, for you are one

Of the time-tested few that leave the world,

When they are gone, not the same place it was.

Mark what you leave."

This lecture focused on civic duty and the responsibility of individuals toward the conservation ideal. It met the criteria for Mastery (EPS4) for Environmental Problem Solving (EPS4) by using historic models from Greek literature and the Bible to show how culture and environment are interrelated. It compared the uses of cultural artifacts such as sticks, stones, billboards, bombs, and bullets with changing societies.

It met the criteria for Accomplished (PCR3) and Mastery (PCR4) for Personal and Civic Responsibility because it identified how ethics are cultural mores. By examining the complexity of cultural mores, students evaluated their actions and choices based upon their membership within the ecological community.

Data Source 31: Tests

Leopold presented a multitude of ways to assess student performance. Students were assessed through projects they selected. They also met individually for a personal interview with Leopold. Essay exams were another assessment given at the end of the term, and Leopold gave several exams throughout the course term.

Problem 3. Phenology. Due April 10. 1, 2, 4, 3

A farmer is spreading manure on a cornstubble. He hurries lest the ground soften before his task is done. Spring peepers and red-wings call from the marsh. The red-wings are all males. A late pheasant crows from the willow thicket.

In the lower field in the lee of the woods a black butterfly with yellow wing-margins hovers in the pale sunlight, and a thrush with a brick-red tail flits silently into the thicket. As the farmer spreads the last of his load along the fence-row a pair of bluebirds flutter around an old post, and a small mammal ducks into a hole, emitting a shrill chatter. A flock of plovers with red rumps flush from a puddle near the barn.

Questions: What time of day? About what date? Identify the butterfly, the thrush, the mammal, the plover. What would you guess is the condition of the fencepost. If you walked down to the marsh, what waterfowl might you expect to see?

Earliest date or hour

peepers calling 3/21
 ♂ redwings present (day 3/6) 3/1
 morning clouds out 4/12
 hermit thrushes present 3/30
 ♂ + ♀ bluebirds paired 3/30
 flock of killdeer going by
 ground squirrel out 3/25 - 4/5

Latest date or hour

spring thaw
 ♀ redwings arrive
 spreading a load of manure

Figure 37a. Tests

Lawrence H. H. H.

Wildlife Ecology 118

Student's Report on
Lectures 1-5

m²⁸

(A) Select from your own experience a case in which changes in plants have affected animals.

1. Where is it? *8 Mi. from Rice Lake Wis; SW $\frac{1}{4}$ SE $\frac{1}{4}$ SEC 7 - T34N R9*
2. When? (Period of time involved) *1931-1938 + some older evidence*
3. How big is the area of which you speak? *3 Acres*
4. Soil, topography, land-use: *Areas of heavy silt loam + 3 to 4' of dark brown to black peat; from woody plant + sedges (Carex). (Texture finely fibrous - structure felty, spongy - fairly loose)*
Top - small glacial marsh; no outlet. Land Use - Ungrazed.

(B) Describe the initial plant and animal set-up: *Carex, Cat-tails, Iris, Cotton blueberry, pincherry, birch slash, willows (Salix sp), Alder (sp), few wh. Ash, 2 areas of canes (Phragmites sp) — Mice, cottonbails, w. gray cats + Marsh wrens, least bitterns, Ringed Grackle, Red-wing. Black bird*

(C) Describe the changes in the initial plant set-up and what induced them:

Attached sheets.

(D) Describe the effects of the changes on the animal set-up:

Attached.

(E) Can you deduce a food-chain or pyramid, or make any other ecological diagnosis of what happened?

Attached.

Note: You may attach a sketch map if necessary to explain your case.

Figure 37b. Tests

Wildlife Ecology 118
Student Assignment No. 2

Name Lawrence Montney A

(A) Breeding index for chipmunk species is as follows:

Eas first young when one year old.

Number of young per year is 9 (2 clutches or litters of 4-5 each).

- (1) Starting with an initial population of 10 breeding adults, and assuming there is a 50:50 sex ratio and no mortality, how many years would it take to reach a population of 1,000 adults?

Answer: 3 years. (Computations attached.)

- (2) Starting with an initial population of 1,000 breeding adults, and assuming that the population is extinguished at the end of 10 years, what approximate mortality rates would produce such an outcome and be probable for the species in question?

Answer: 50 per cent in adults)
99 per cent in young) computations attached

- (3) Reference for your assumed breeding index Seton's "Lives", p. 193

(B) Select two titles you have read (do not use Leopold's titles) and give for each:

- (1) Complete reference
- (2) A brief descriptive review (not over 1/2 page)
- (3) Your inferences as to the author's viewpoint and personality (not over one paragraph)
- (4) Your criticism of the subject matter (not over 1/2 page)

Figure 37c. Tests

The assessments Leopold provided furnished the student with opportunities to be evaluated in various degrees. The assessments captured the four levels (QA1), (QA2), (QA3), and (QA4) of Question and Analysis in Figure 37b and 37c, as students had to derive from their experience a model of a food pyramid on a particular species of their choosing. In Figure 37a, students must be able to evaluate a scenario based on their knowledge of the flora and fauna and the relationship of patterns, reciprocity, and life cycles. The scenario described the broader application of how ecosystems operate. This encompasses the four levels (KPS1), (KPS2), (KPS3) and (KPS4) of Knowledge of Processes and Systems. The phenology test question also matches criteria (EPS1), (EPS2), (EPS3), and (EPS4) for Environmental Problem Solving from the description of the farmer and the practice of agriculture with regards to its relationship to the environment.

Data Source 32: Field Trips

Field trips were an important part of Wildlife Ecology 118. Students visited Faville Grove, the University Arboretum, and The Shack, and took walks around the UW campus, where Leopold would point out various natural features. Much of the recollection of his field trips was captured by his students and staff in proceedings that were produced from the Aldo Leopold Centennial Symposium (McCabe, R.E., 1987).

One of Leopold's secretaries, Alice Harper Stokes, noted:

A standing rule was if the thermometer registered 15 degrees or more above zero, the field trip was on; if colder than that, the students were not to gather. On field trips, Professor Leopold would point out browse lines, animal tracks and scat. He pieced together little signs that told of the previous night's activities—which animals were out, what they were doing and the condition of the landscape. Spring and fall trips were equally exciting. He had a unique ability to kindle students' interest in wildlife by encouraging them to, on early morning trips, to watch the 'booming'

displays of prairie chicken, evening trips to witness the 'peenting and sky dance' of woodcock, and day trips to hear the 'drumming' of ruffed grouse.

He stimulated interest in others in phenology, and would draw out their observations of when flowers began to bloom, migrating bird arrivals and departures, etc., and let them know that this information was important to him. By his example, his suggested readings, his interpretations of natural events, Professor Leopold instilled a sense of joy in Nature among his students and other associates (pp.88-89).

Robert Ellarson, a graduate student, described a Wildlife Ecology 118 field trip that he went on with a friend. He later enrolled in the class.

The highlight of the course was a trip to his Shack in Sauk County. It took place in the spring and the whole class attended. We began the outing by planting pines and tamaracks south of the Shack to expand The Professor's previous plantings. Later, we took a walk around the property and located some beaver cuttings, which I believe constituted the first beaver sign he had ever noted on the farm.

The Professor showed us an area where he was cultivating a field on a rotational basis, to encourage weeds as cover and food for quail and pheasants. That area held quail, but pheasants were uncommon. I also recall that particular trip because The Professor called my attention to the songs of tufted titmice and bluegray gnatcatchers. It was the first time I heard (or at least listened to) the songs of these birds (pp. 13-14).

James B. Hale was introduced to Leopold by participating on a Wildlife Ecology 118 field trip by invitation.

Saturday came and the small group—two cars full, as I remember—departed for Faville Grove. Upon arrival, I was dutifully introduced to The Professor, who was cordial and said he didn't mind my being there. The remainder of the day was an eye-opener. There were many high points, including the first white lady's slippers I had ever seen, and a family of barn owls in the Faville's barn. I was especially impressed with the depth of The Professor's knowledge and interpretations of the wild things in the Faville Grove area (p. 22).

The field trip met criteria for Accomplished (PCR3) as students practiced environmental stewardship by planting trees at the Shack. Knowledge of Processes and

Systems was included on all four levels (KPS1), (KPS2), (KPS3), (KPS4) as Leopold guided field trips and helped students learn to observe organisms and their interactions with ecosystems on various levels. Question and Analysis was included on three levels (QA1), (QA2,) (QA3) when Leopold showed students various environmental problems at the different sites they visited. For example, field trips to the Arboretum were demonstrations of the re-introduction of native species to an area that had been environmentally diminished from poor conservation practices. Leopold led investigations by pointing out contextual factors and clues that showed how species were identified and related to a particular environmental situation. This matches the Mastery level (EPS4) for Environmental Problem Solving.

RQ 2: What was the context for the lessons in Wildlife Ecology 118?

The purpose of RQ2 was to contextualize historically the lessons of Wildlife Ecology 118. The context could then be identified into categories that would show how Leopold derived his lessons for Wildlife Ecology 118. There were four categories for context: recreational, research, professional development and public service. The research derived the contexts from the 32 data sources by examining archival records and *Game Management* (1933/1986), *A Sand County Almanac* (1949/1970), Meine (1988) and McCabe (1987; 1988).

Recreational/leisure

Leopold's leisure activities consisted of hunting and fishing and excursions to the Shack (Meine, 1988). In 1936 the Leopold family established a getaway at The Shack on the Wisconsin River. These recreational retreats turn into elaborations of Leopold's desire to return the worn-out property into a wilderness refuge. Diary entries, made by

Leopold family members and guests when at the Shack became sources of phenological records. Leopold referred to phenology as a “personal sort of science” where one “may even fall in love with the plants and animals which so regularly fulfil [sic] his predictions” (Leopold & Jones, 1947, p. 83). This personal description put Leopold’s use of phenology into a leisurely context, but was quickly converted to scientific records by Leopold that lead to restoration efforts as demonstrations for field trips in both game management and Wildlife Ecology 118 classes. Detailed bird charts and graphs from phenology became products from Shack visits as well, along with maps that indicate various study plots on grasses. Figure 93 shows the first entry for the Shack Journal and included phenology notes on blooms of violets, yellow lady slippers, Baptisia, spider wort, and anemones. A breeding was noted of a yellow-bellied sapsucker. Sorghum growth is measured.

Journal for 1935.
(date previous to July 1 are approximate)

Jan 12. Visited place with Ed Ucheener and asked him to lease it.

Feb 3. Started work on fireplace with Starker & Limer

Apr 20-24. Camped with Limer & Carl & Limer. Finished roof. Carrying this.
Foundation, bunkhouse, spring. (ACL)

Apr 27-29. Camped with Hammertons. Violets and Indian Sweet Grass
blooming.

Bought place through Ed Ucheener.

May 19. Planted food-patch.

June 20? Yellow lady-slippers in bloom in Lewis woods.

June 30 Completed clay floor with Carl & Donald Mc Beatts. First
Baptism in bloom. Spiderwort & Anemone in full bloom.

July 5-6 Run out by mosquitoes - went to Barboe tourist camp for
night. Finished batten on front. Sorghum in plants 12" high.
First black-eyed susans in bloom.

July 13 Baptism apparently over with but still some spiderwort
and much black-eyed susan. Sorghum 15" high. Uncovered
yellow-bellied Sapsucker is breeding in above shack.
Finished batten on north and west side.

September 20 - Rained, Mary, mother and the children out for the day.
Sorghum 5 to 6 ft high in good condition. Cato ripe and Green
baked. Snow Peas? mostly ripe in great quantities. Beans
green & full of seed. The corn not yet turning.

Figure 38. First Shack Journal entry

The earliest use of phenology by Leopold occurred in his activities with A.W. Shorger in a recreational setting, the Kumlein Club. As mentioned in Chapter 3 of this study, Shorger and Leopold became good friends when Leopold moved to Madison and they helped to form the Kumlein Club. Shorger had used his phenology records to publish an article on birds in the *Wisconsin Academy of Science* several years before meeting Leopold (Shorger, 1923).

Data Source 2: Suggestions for Projects and Data Source 5: Phenology Lecture focused on the topic of phenology. In Data Source 4: Putting the Sciences Together, the lecture referred to the cardinal singing on campus (Figure 10). Phenology notes in the following (Figure 39) shows Leopold's entries of cardinal song in January when the cardinal singing was heard at different places and, in some instances, was recorded by other Kumlein Club members.

Figure 39. Cardinal Phenology

Data Source 6: Reading the Landscape, described the depth of meaning that Leopold used to teach his students about the operation of ecosystems. Reading the Landscape was a culmination of activities that came from various contexts; it was placed with phenology but also found in a combination of other experiences that crossed

professional development, work and public service.

Ernie Swift, a colleague of Leopold's who worked for the Wisconsin Conservation Department, was known for his historical perspectives that Leopold admired (McCabe, 1987). Meine (1988) refers to Swift's experience on a field trip with Leopold where Leopold pondered the placement of a solitary great oak tree on a high hill and its proximity to a younger forest close by. These ponderings were questions often placed by Leopold as he led student field trips asking students why certain plants were located where they were, what human activities had changed the area, etc. (McCabe, 1987).

Reading the landscape was a skill that Leopold had acquired over the years in his job as a district forester in Arizona, in his hunting trips, in his work with the Civilian Conservation Corps, with the game surveys that he conducted and in his various travels across the United States, Canada and Europe. Leopold's activities which took him into various ecological landscapes gave him the advantage of comparing ecosystems and their vitality. Phenology helped to bridge the ability to read the landscape by observing the details of individual components of living plants and animals and their associations with the environment wherein they lived.

Data Source 7: Case 1: History of a Roadside and Data Source 12: Case 6: Evolution of a Fencerow served as additional examples of Leopold's ideas of reading the landscape. He placed the culture contexts of fences and roadside and plotted them against the biological landscape to identify the impacts of historical events that changed the scenery. These cases showed a progression of Leopold's ideas, which culminated in *A Sand County Almanac*, to place human activity within the boundaries of a biocentric

universe by providing historical perspectives.

Data Source 30: Motives for Conservation, Closing Lecture: This lecture was written to empower students to act as responsible citizens of the ecological community. Major ideas and direct quotes from this lecture were later used for The Land Ethic section of *A Sand County Almanac* (1949/1970). It is this particular section of *A Sand County Almanac* (1949/1970) that has credited Leopold with defining the direction of the current environmental movement, placing humanity within the context of the eco-centric universe. The researcher placed this Data Source under recreational/leisure, because it was published in *A Sand County Almanac* (1949/1970); however, Leopold went in great detail to give a historic perspective in Chapter One of *Game Management* (1933) which was written and published many years before *A Sand County Almanac* (1949/1970). A strong case could be made for both categories.

Research/Work Related

In 1928, prior to Leopold's tenure at the university, he worked for the Sporting Arms and Ammunitions Manufacturer's Institute to conduct game surveys in Michigan, Minnesota, Iowa, Ohio, Mississippi, Illinois, and Indiana. These surveys resulted in the *Report on a Game Survey of the North Central States* (1931) and became the basis of his book *Game Management* (1933). The surveys concentrated heavily on quail, pheasant and deer populations and are the basis for much of Leopold's work as it continues with his establishment of the University of Wisconsin's wildlife management program. He was the first to publish data that was so extensive on the habitat and behavior of game animals and received national recognition for his efforts.

Data Source 24: Range, Data Source 20: Wildlife Technique and Data Source: 23

Weight Ratio are examples are material that are discussed in *Game Management*(1933).

Game populations of whitetail deer, grouse, quail, turkey, cottontail, waterfowl, partridge, woodcock and pheasant are extensively researched in the book. These compilations of research became extended research topics through the Leopold's wildlife management department at the university and he arranged for many of his graduate students to extend this work.

Data Source 21: Animal Populations and Data Source 22: Population Census provided a snapshot of the research and field trip areas that were most often visited by Wildlife Ecology 118. The University Arbortum was a 500 acre area on the southern edge of Madison that was established for biological research. It contained a mix of pastures, woodlots, marshes, and prairies. It still exists today as a research area with emphasis on native plants, wildflowers and nature trails for the general public use. Lake Wingra borders the Arbortum and much of the Madison district.

The Riley area referred to the Riley Game Cooperative organized by Leopold, comprised of 11 farmers working with local businesses, to provide a hunting area. The farmers received operating funds from the local businesses to help improve their lands, by stocking small game birds and providing winter feed, so that wildlife game numbers improved.

Prairie du Sac is a township area that borders the Wisconsin River, about 15 miles north of Madison. Paul Errington, a biologist from University of Wisconsin, began quail studies in this area in 1929 that lasted throughout Leopold's tenure. Leopold and Errington worked together on quail research and shared graduate students on several quail projects. Errington demonstrated that quail populations are more sensitive to cover

and food needs than pressures from predators and hunting (McCabe, 1987).

Several of the case histories in the data are examples of extended research from the work of Leopold's graduate students. Data source 10: Case 4: History of a Central Wisconsin Marsh and Data Source 13: Case 7: History of a Tussock Marsh referred to the area of the "sand" counties in south central Wisconsin. These counties were identified by their sandy, loam soils surrounding marshes in low lying areas where rivers snaked through valleys. The marshlands were part of a survey that Leopold conducted for the Wisconsin Conservation Commission and Biological Survey in hopes of establishing a proposal to form a Central Wisconsin Conservation District (Meine, 1988).

Many of Leopold's graduate students did their research in the sand county areas. Franklin Schmidt was one of Leopold's first graduate students. He worked on the sharptailed grouse and prairie chickens in these counties. Frederick Hamerstrom and his wife, Frances, both became graduate students of Leopolds and took over studies of the prairie chicken in central Wisconsin after Schimdt's untimely death (McCabe, 1987). The Hamerstroms began their work on quail under Paul Errington in Prairie du Sac. One of Leopold's well-known literary pieces, Marshland Elegy was inspired by his first witness of sandhill cranes in this region (Meine, 1988).

Data source 9: Case 3: History of a Ragweed Patch was taken from the research at Faville Grove. Faville Grove, as mentioned previously, was a demonstration of a cooperative game management area that Leopold organized, between farmers and hunters. Irven O. Buss, Art Hawkins and Bob McCabe were Leopold's graduate students who did research projects at Faville Grove on upland sandpipers, pheasants and partridge (McCabe, 1987).

Data source 8: Case 2: History of a Prairie Coulee came from the Coon Valley Project in 1938 that was initiated by the Soil Erosion Service funds as a national demonstration project. Coon Valley was in southwestern Wisconsin and selected as a national demonstration because of the massive erosion problems created by pioneers as they tried to till thin soils on steep slopes (Meine, 1988). These situations were typical across the United States (the Dust Bowl was the primary force that established a wave of national erosion control efforts by the federal government).

Data Source 14: Case 8: History of Gilbert Creek, Dunn County was put together by Leopold's graduate student, Irven O. Buss. Buss was one of Leopold's first graduate students, arriving in 1936. He worked on the Faville Grove management area with another graduate student Art Hawkins, compiling data on gray partridges, pheasants and quail. Buss took quail surveys in Dunn County, WI., which was Buss's native home (McCabe, 1987).

Data Source 27: Deer Problems is the result of one of the most important management issues during Leopold's career. As a forester, he was educated by the classic Kaibab Deer case, in the early 1920s that occurred in southwestern Arizona where the removal of mountain lions forced deer populations to explode, resulting in deer starvation and severe habitat damage. The charts from Michigan, Pennsylvania and North Carolina, come from personal encounters with colleagues who were involved in conservation efforts to control wildlife management issues.

Data Source 16: Biography of a Flock and Data Source 18: Biography of a Covey are examples of work that Leopold had compiled over the years from his game management surveys in the 1930s, to his continuing quail studies with Paul Errington and

from the work of his graduate students. The biographies create the scenarios of the events that quail and pheasant encounter during the course of a year. Leopold's literary piece, *A Sand County Almanac* (1949/1970), reflects this earlier style that Leopold developed to teach his students about the interdependence of animals on their environments.

Data Source 17: Biography of a Great Horned Owl was pieced together by one of Leopold's graduate students, Francis Hamerstrom, in the same style as the other two biographies. Hamerstrom's graduate research, along with her husband, Frederic, began on quail studies with Paul Errington at the University of Wisconsin but then shifted to Leopold's program, as she became interested in his fieldwork. All three, Frances, Frederic and Paul, published a research bulletin together on the great horned owl for the Iowa Department of Agriculture. Frances Hamerstrom was the only female charter member of The Wildlife Society (McCabe, 1987).

Professional Development

As mentioned in Chapter 3, one of the most influential scientists in Leopold's career was when he met Charles Elton. Leopold had received an invitation to attend an international conference of biologists meeting at a retreat on the Metamuk River in Quebec in 1931. The Metamuk Conference was a meeting to discuss the new topics around cycles and patterns that affected wildlife. Charles Elton, who attended the conference, presented his paper on cyclic trends of fur-bearing animals based on fur trade records dating back several hundred years from the Hudson Bay Company (Meine, 1988).

Elton's *Animal Ecology* (1927) contained some of the first information on

predator/prey relationships and included diagrams of food chain associations between animals. Leopold quickly became friends with Elton, applying Elton's research to his fieldwork. Data Source 25: Food Chain Definitions and Data Source 26: Food Chain Diagrams are very similar to Elton's descriptions and presentations of food chains and ecological associations.

Data Source 29: Ecosystem in Broader Applications relates to Leopold's Germany visit from a sponsored invitation of The Oberlaender Trust. For three months in the Fall of 1935, Leopold and four other foresters, studied the German forests in relationship to game management of species. From this trip Leopold saw the affects of long-term German forestry management to produce maximum forestry yields and maximum game species. The result was a loss of forest and wildlife that yielded a sterile, distorted landscape lacking wilderness diversity.

Data Source 29 occurred as a result of a professional development experience and encapsulated a culmination of Leopold's experiences from across the contexts of his life. Just as in Reading the Landscape, the ability to compare ecosystems was a personal advantage that Leopold possessed as a teacher from his activities stemming from hunting trips, research, restoration program efforts, and travels in various capacities. He was connected with other great ecologists and biologists who were creating the field of wildlife management and could compare and contrast their research that reached from South America to Canada and across Europe.

Public Service

Data Source 11: Case 5: History of Northern Wisconsin outlines the scenario of a very real dilemma that confronted Leopold's work on the volunteer committees.

Leopold served on two volunteer committees during the early 1940s, the Wisconsin Academy of Sciences and the Citizen's Deer Committee, to address the growing problem of deer overpopulation in the northern Wisconsin forests. Leopold's experience with deer management was not limited to his tenure on these committees. Leopold had personally witnessed the decimation of habitat when predators were removed from an ecosystem. Over the years of his experience, he concluded that predators should be re-introduced and game seasons exercised to reduce deer. His opinion was often unpopular among nature lovers, who liked to deer watch, and among farmers, who favored predator eradication.

Data Source 28: Factors of Population Fluctuations include a chart taken from Jay "Ding" Darling. Darling was a colleague of Leopold's who, like Leopold, believed that large expanses of game reserves and improved habitat were the most important factors for supporting wildlife game populations. An avid cartoon artist and conservationist, Darling and Leopold served, along with Thomas Beck, on a volunteer committee appointed by President Franklin Roosevelt, to outline plans to purchase agricultural lands for wildlife refuges (*New York Times*, 1934).

CHAPTER V

SUMMARY AND CONCLUSION

This chapter is organized into three sections: (a) Summary and Discussion of Findings, (b) Generalizations of Findings to Literature, and (c) Implications and Suggestions. The Summary and Discussion of Findings is organized into two subsections that address RQ1 and RQ2. The second section, Generalizations of Findings to Literature, links the findings of the study to the previous literature. The last section, Implications and Suggestions, focuses on the suggestions and application for the study for educators, researchers, and policy makers interested in incorporating environmental education practices.

Summary and Discussion of Findings

This section is organized into two subsections: (a) comparative historical analysis of the lessons in Wildlife Ecology 118, and (b) environmental history analysis of the context for Wildlife Ecology 118. In subsection one, the Four Strands for Environmental Education are compared to the Wildlife Ecology 118 lessons and summarized on a matrix. In subsection two, the researcher used an inductive approach to group lessons together with similar contexts to organize them into four categories: recreational/leisure, research/work related, professional development, and public service. The themes were identified to their contextual origins and give perspective on Leopold's choices for developing the lessons in Wildlife Ecology 118. There were five themes: (a) case

histories, (b) animal biographies, (c) phenology applications and field techniques, (d) food chains and, (e) ecosystem examples.

RQ 1: Comparative Analysis of the Lessons in Wildlife Ecology 118

The researcher used the rubric developed in Chapter Two (Table 4), and created a matrix (Figure 40) for comparison of the lessons of Wildlife Ecology 118 to the Four Strands for Environmental Education. Thirty-two data sources were selected for analysis against the Four Strands.

Data Source	Rubric for x																	
	QA1	QA2	QA3	QA4	KPS1	KPS2	KPS3	KPS4	EPS1	EPS2	EPS3	EPS4	PCR1	PCR2	PCR3	PCR4		
D.S. 1: Course Intro.	x	x	x			x	x	x			x	x	x				x	
D.S. 2: Projects	x	x			x	x	x	x										
D.S. 3: Outline	x	x		x	x	x					x	x	x					
D.S. 4: Put.Sci To.	x	x	x	x	x													
D.S. 5: Phenology Lec.		x			x	x	x	x										
D.S.6: Rding Landscape	x	x	x	x	x	x	x	x			x	x						
D.S. 7: Case 1 Roadside	x						x				x	x					x	
D.S. 8: Case 2: Pr. Cou.				x	x		x	x			x	x					x	
D.S. 9: Case 3 Ragwd				x	x	x	x	x			x	x					x	
D.S.10: Case 4: Marsh					x	x	x	x	x	x	x	x						
D.S. 11: Case 5: N. WI				x				x	x	x	x	x						
D.S. 12: Case 6: Fence									x	x	x	x					x	
D.S. 13: Case 7: Marsh					x	x	x	x	x	x	x	x						
D.S. 14: Case 8: Gil.Cr.					x	x	x	x	x	x	x	x						
D.S. 15: Conclusion							x	x				x					x	
D.S. 16: Bio of a Flock		x			x	x	x	x			x	x						
D.S. 17: Bio Gr.H.Owl	x	x			x	x	x	x				x						
D.S. 18: Bio of a Covey	x				x	x	x	x	x	x	x	x						
D.S. 19: Deduc.Bios.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
D.S. 20: Wildlife Tech.	x																	
D.S. 21: Animal Pop.					x	x	x	x										
D.S. 22: Pop. Census					x	x												
D.S. 23: Weight Ratios		x				x												
D.S. 24: Range						x	x											
D.S. 25: Food Ch.Defin.						x	x											
D.S. 26: Food Diagram					x	x	x	x	x	x	x	x						
D.S. 27: Deer Prob.					x	x	x	x	x	x	x	x						
D.S. 28: Pop.Flucuat.							x				x	x						
D.S. 29: Eco.Br. App.									x	x	x	x						
D.S. 30: Closing												x				x	x	
D.S. 31: Tests	x	x	x	x	x	x	x	x	x	x	x	x						
D.S. 32: Field Trips	x	x	x		x	x	x	x				x				x		
Totals:	10	10	6	8	20	22	23	20	11	11	19	23	3	1	3	7		

Figure 40. Rubric matrix for comparison

The 32 data sources (D.S.) analyzed in Chapter Four are listed in the left column. The columns to the right of the data represent the Four Strands of Environmental Education with the levels of criteria for each strand: QA1=Question & Analysis Beginning, QA2=Question & Analysis Developing, QA3=Question & Analysis Accomplished, QA4=Question & Analysis Mastery; KPS1=Knowledge of Processes & Systems Beginning, KPS2=Knowledge of Processes & Systems Developing,

KPS3=Knowledge of Processes & Systems Accomplished, KPS4=Knowledge of Processes & Systems Mastery; EPS1=Environmental Problem Solving Beginning, EPS2=Environmental Problem Solving Developing, EPS3=Environmental Problem Solving Accomplished, EPS4=Environmental Problem Solving Mastery; and, PCR1=Personal & Civic Responsibility Beginning, PCR2=Personal & Civic Responsibility Developing, PCR3=Personal & Civic Responsibility Developing, PCR4=Personal & Civic Responsibility Mastery.

There were 23 data sources from Wildlife Ecology 118 that matched criteria levels for Mastery in Environmental Problem Solving (EPS4) and Accomplished in Knowledge of Processes and Systems (KPS3). For the Case Histories, which comprised a large portion of the course content, Leopold used evidence and models to provide a continuum of examples to build efficacy and skills for environmental problem solving. Other matches that yielded high numbers (19-22) were in criteria Beginning (KPS1) Developing (KPS2) and Mastery (KPS4) of Knowledge of Processes and Systems and Accomplished (EPS3) of Environmental Problem Solving.

Data that matched for Question and Analysis (QA) were from tests, field trips, projects, and wildlife technique. Assumptions could be made that there would have been a higher number of matches in the criteria for QA, but it was not possible to fully evaluate these particular activities since they occurred outside of the archival records. The lowest criteria areas were in Personal and Civic Responsibility. The researcher expected this Strand to score the lowest. It was difficult to measure the criteria from this strand because it directly affected student behavior, a variable that was not measured or included as a part of the course. The 1987 Symposium (McCabe, 1988) that united

former students and staff of Leopold's contained many testimonials to indicate that attendance in Wildlife Ecology 118 was pivotal in directing behavior to environmentally responsible choices.

Leopold used the lessons from Case Histories and Animal Biographies to apply ecosystem conditions and problems that ranged from Wisconsin to the Southwest, Asia and Europe on a broad level. He interjected morality and ethics in the closing lecture to guide conservation efforts for environmentally responsible choices in the future.

RQ 2: Environmental History Analysis of the Context for Wildlife Ecology 118

For this subsection the researcher used the 32 data sources from RQ1 and provided a summary of the contexts for the data. The researcher concluded there were four main categories that could be used to group the contexts: recreational/leisure contexts, research/work related contexts, professional development contexts, and public service contexts (Figure 41). From these contexts there were five themes that emerged for Wildlife Ecology 118: (a) case histories, (b) animal biographies, (c) phenology applications and field techniques, (d) food chains and, (e) ecosystem examples.

Data Sources	Contexts:			
	Recreat./Leisure	Research/Wk.	Prof. Dev.	Public Serv.
Data Source 1: Course Intro.				
Data Source 2: Sugg. Projects	x			
Data Source 3: Lecture Outline				
Data Source 4: Put. the Sci To.	x			
Data Source 5: Phenology Lec.	x			
Data Source 6: Rding the Landsc.	x			
Data Source 7: Case 1: Roadside	x			
Data Source 8: Case 2: Pr. Coulee		x		
Data Source 9: Case 3: Ragwd P.		x		
Data Source 10: Case 4: Marsh		x		
Data Source 11: Case 5: N. WI				x
Data Source 12: Case 6: Fencerow	x			
Data Source 13: Case 7: T. Marsh		x		
Data Source 14: Case 8: Gilbert Cr.		x		
Data Source 15: Concl. Cases				
Data Source 16: Bio of a Flock		x		
Data Source 17: Bio Gr. H. Owl		x		
Data Source 18: Bio of a Covey		x		
Data Source 19: Deduct. Bios.				
Data Source 20: Wildlife Tech.		x		
Data Source 21: Animal Pop.		x		
Data Source 22: Pop. Census		x		
Data Source 23: Weight Ratios		x		
Data Source 24: Range		x		
Data Source 25: Food Ch. Defin.			x	
Data Source 26: Food Ch. Dia.			x	
Data Source 27: Deer Problems		x		
Data Source 28: Pop. Flucuat.				x
Data Source 29: Eco. Broader App.			x	
Data Source 30: Closing Lecture	x			
Data Source 31: Tests				
Data Source 32: Field Trips	x	x		x
Total:	8	15	3	3

Figure 41. Context for Wildlife Ecology 118

Fifteen of the lessons came from research in *Game Management* (1933) and the work in the field carried out through Leopold and his graduate students. His graduate students added to the depth of information on select species studies at wildlife management areas that Leopold helped to establish. These areas include the Arboretum, Faville Grove, Prairie du Sac, and the marsh studies at the Coon Valley project in southern Wisconsin (McCabe, 1987).

Eight of the lessons centered on activities that came from phenology records that

were introduced as a recreational activity. Leopold's phenology started as a pastime that developed as a basis of research, literature, and teaching. These notes turned into a succession of comparative observations on individual species over time so they could be manipulated to show how even the smallest changes in the environment can impact organisms in a very big way. Data Sources 2, 4, and 5 that focused on phenology were often applied as a technique for creating activities that could be used to read the landscape and compare specific species from ecosystems that could be applied on a broader level.

Three public service contexts were from volunteer service on committees that tackled the deer problems in Wisconsin. Leopold used his experiences in deer management problems to highlight complicated environmental issues. The deer problem example showed a wide range of public opinions that created a complicated dilemma with international applications. The three lessons from professional development came from Leopold's experiences from conferences that he attended and his trip to Germany. Leopold's trip to Germany had a profound impact on his view of wildlife management. Germany accentuated the problem of managed landscapes that resulted in loss of biotic potential or ecosystem health.

Emerging Themes. There were five themes for Wildlife Ecology 118: (a) case histories, (b) animal biographies, (c) phenology applications and field techniques, (d) food chains and, (e) ecosystem examples. A majority of the lessons used case histories featuring changes in landscape over specific time frames. The landscapes were written into case histories to present a historic picture of the ecological happenings that changed a particular place. In a few instances, Leopold used the research from his graduate

students to add to the accuracy of a particular case history.

The animal biographies illustrated associations of animals with their environments throughout the course of the year. Leopold created animal biographies to demonstrate how animals depended on their environments, how seasonal changes affected a particular species, and how these patterns fit into the ecological story of a particular place. The seasonal changes described in the biographies highlighted the dependency of animal to place and what particular aspect of the environment could support that animal's life.

Phenology helped simplify the complex associations of living organisms and their environmental responses. Through phenology, observations of species, both from field trips and classroom slides, identified species and their relationships within their own habitats. Field trips were used as immersion experiences to physically and mentally engage students with their environments. Field techniques included application of weight ratios and population counts that demonstrated the dynamics of energy and flow through the food chains. Field trips also included students planting trees and improving native habitats. Diagrams of food chains and webs helped students to visualize the associations of living things with each other. Food chains reinforced the concept of energy and the way it moves through ecosystems, showing the patterns of interrelationships between species.

Leopold pulled from his broad knowledge of wildlife experiences, both professionally and personally, to provide a large snapshot of ecosystem models across the world. By doing so, he used historic perspectives for comparison in specific places to deepen the students' understanding of complex environmental problems. With this

knowledge as a base, students could read landscapes in various situations and pull from past examples of specific cases for thoughtful deliberation on future problem solving.

Generalizations of Findings to Literature

The following connects the findings from the study on the first two subsections from Chapter Two: (a) Civic Engagement through Environmental Strategies and (b) Key Environmental Issues during Leopold's Career. These two sections are directly tied to the research questions RQ1 and RQ2.

RQ1: Civic Engagement through Environmental Strategies

Environmental Problem Solving and Knowledge of Processes and Systems from the Four Strands for Environmental Education are the dominating themes that resonate throughout Wildlife Ecology 118. The following subsections will discuss in detail the application of these dominating themes as strategies for Wildlife Ecology 118.

Environmental Problem Solving. Environmental problems are multi-level and complex (ICCE, 1997; NEETF, 1999). Environmental problem solving requires that people understand natural processes and apply that knowledge to local environmental issues (Cobern, 1988). The presentation of the Case Histories from Wildlife Ecology 118 helped to increase environmental awareness by connecting the current environmental issues of the time, such as erosion, loss of biodiversity, etc., with information that was already known, such as historic cases. By connecting the past problems to the present situations, students could “make sense” of the more complex tasks solving environmental issues.

This “making sense” feature shows how historic examples become shared information that reinforces other similar features that are stored in memory. Advanced

problem solvers appear to have at their disposal the memory record of a variety of strategies and problems that they can call on for solutions (Lawson, 2003). Exposure to a variety of strategies and skills creates contradictions in the brain that in turn, arouse behaviors that can cause change (Lawson, 2003; Piaget, 1968; 1970). This is essential for building knowledge and changing behavior.

Knowing the stories of people and understanding historical patterns of land use and cultural values through Leopold's case histories allows students to blend and integrate knowledge so that they can recall it effectively and apply it to other situations (Lawson, 2003). By viewing patterns of relationships over a period of time, students of Wildlife Ecology 118 could integrate these patterns for future problem solving.

The other factor that Leopold utilized for problem solving occurred with the immersion of his students into the relevant and local environmental issues within the local community. He selected projects (D.S.2) that would give students direct involvement with the local natural resources. He led students on field trips that were relevant and engaging. Students physically planted trees, observed wildlife, kept phenology records, visited wildlife projects. These activities gave students a real world understanding about the overall natural processes that could be applied toward environmental knowledge (Cobern, 1988). The living plants and animals of an ecological world were not in a separate, distant place but were relevant and relational to the lives of the students (Loughland, Reid, Walker, & Petocz, 2003).

Wildlife Ecology 118 was designed to place students within the experience of the natural world. Leopold required students to participate in field trips and included part of the course assessment to be based on student-selected field projects. These authentic

experiences are essential for environmental understanding of the physical world and provided a mental record of what was done and seen.

Knowledge of Processes and Systems. Studies (ICCE, 1997; NRC, 1996) from the community of environmental educators indicate that more substantive content in the natural sciences is needed. To embody natural science, students must have the skills to identify the physical components of the environment. Leopold gave students the empirical skills and techniques to identify the environment around them and then connect them from plant to animal, animal to place, place to environment. These skills become the factual knowledge that underpins important concepts throughout the course, from the Case Histories, Animal Biographies, Field Trips, Student Projects and Tests.

Factual knowledge provided the foundation for building the framework that contained the information necessary to understand the complicated network of relationships in ecosystems such as reciprocity and feedback (Grotzer, Donis, & Shaw, 2000). Understanding the facts and ideas in a context facilitates the retrieval and application of information in the brain so that it can be accessed to understand these complex, ecological concepts (Donovan, 2002).

Misconceptions from ecological principles often occur when there is no direct connection to an event or happening (Bell-Basca, Grotzer, Donis, & Shaw, 2000; Capra, 1999; Grotzer & Bell-Basca, 2001; Resnick, 2002). Because passive flows of energy are not readily observable, students must be shown how these complex systems operate. Leopold used many diagrams (D.S. 21, 22, 23, 24, 25, 26, 27, and 28) on animal populations, weight ratios, range, and food chains to demonstrate the variety of ways that energy presents itself through an ecosystem. Furthermore, Leopold grounded these

models in local problem-solving events such as the deer issues in Wisconsin and the forest issues in Germany. Thus the effectiveness was enhanced for the educational experience by the students (Coyle, 2004).

The phenology techniques that are found within the data (D.S. 2, 3, 4, 5, 6, 31, and 32) were tools that place living organisms within the context of their environments. By associating the needs of the organisms with the various aspects of the environment, students collected information about the plants and animals that surrounded the local community. As Leopold gave identity to the uniqueness of the species within their context, students learned to identify the special places and features of the landscape that gave it importance (Relph, 1976; Tuan, 1974).

The landscape features become a pattern of recognition that give order and meaning (Piaget, 1970; 1971; Burton, 1993; Barkman, 2000; Decampo et al, 2000; Volk, 1995). Order and meaning give value to day-to-day living in which consciousness and environment become intertwined (Capra, 1996). This gives context to the concept of a living earth that embraces the ecological network where life and death are intertwined to provide a living network of life support (Lovelock, 1979; Margulis & Sagan, 1997; Orr, 1992). Leopold's strategies for Wildlife Ecology 118—to engage students to become better citizens of the ecological community—are notably through the field trips and field projects where students became immersed in the outdoor settings. The complex and varied settings of outdoor experiences enriched and challenged mental and physical activities that helped to capture significant events. These activities reinforced classroom lectures that provided analogous, realistic experiences to inspire environmentally responsible behavior.

RQ2: Key Environmental Issues for Wildlife Ecology 118

Leopold's life was placed in the context of emerging environmental issues that have reached international proportions in today's global society. Loss of biodiversity, erosion, and resource misuse were key topics that have persisted and enlarged in scope to global proportions (Roosevelt, 1913/1985; Worster, 1988; 1993). These issues encompassed the use of technology and cultural mores that change perceptions about the way place is perceived and used (Bowers, 2001). Leopold's case histories and animal biographies are particular good models which give identity to the ecological landscape and illustrated the context of these emerging issues.

The Case Histories from Wildlife Ecology 118 are fruitful for study by educators in the way they were interjected for illustrative examples. By drawing from personal experience and historic research, Leopold created stories that could help clarify long term misuse of resources that resulted in ecological damage. Leopold witnessed the large loss of biodiversity and poor land management practices that caused a multiplicity of problems such as erosion of soils, contamination of water, and the large scale depletion of resources (Flader, 1974; McCabe, 1988; 1988, Meine, 1988). Leopold showed how cultural practices in industry, such as forestry and logging, and agricultural practices, such as cattle ranching and crop cultivation, were used as ethical scenarios to question if the means of practices justified the end results (Bowers, 2001).

Several examples of government interventions were given to provide solutions to conflicts on conservation issues of the time, such as the deer overpopulation problem in northern Wisconsin (D.S. 27). In some of these cases, Leopold interjected successful

scenarios (D.S. 8) while others questioned the wisdom of government regulation and practices (D.S. 10, D.S.11).

Leopold used his Germany trip (D.S. 29) and historical references (D.S. 30) from literature to frame ethical practices within the context of cultural mores. Ethics are based upon worldviews that are determined within a social structure (Campbell, 1993). This idea is central to the premise for a biocentric universe that Leopold developed, with an ethic that considers an organic relationship between humans as well as all life on Earth (Darwin, 1859/1998; Demasio, 1994; Eisler, 1987; Gimbautus, 1999; Jung, 1993; Maynard-Smith, 1986; Stone, 1976).

Central to ethical choices is the creation of technology and the implications of its aftermath (Bowers, 2001). Leopold witnessed the rise of the automobile that created massive highway construction projects in the United States. Large chunks of land were modified for logging operations and large scale agricultural practices. Leopold interjected cultural symbols, such as roadsides (D.S. 1) and fences (D.S. 6) in the Case Histories as examples of these technological changes.

The profound meaning of places began to deteriorate from technological change and has aggressively advanced into the 21st century. The deterioration of biodiversity and deterioration of places that had been rich in historic value offer little challenge for creative thinking (Ellen & Fukui, 1996; Kuo, 1967). Leopold recognized the cultural symbols of fences and widened roads as a break from historic landscapes that would create a new pattern of identity far different from an ecologically rich setting (Bowers, 1995; Relph, 1976; Tuan, 1974).

Identity is central to the way Leopold incorporated the wildlife species issues of his time. Animal biographies (D.S. 16, 17, and 18) and deer lessons (D.S. 27 and 28) are examples of dilemmas that are carried out on a daily basis between wildlife and human contact. Leopold used familiar contexts that could be experienced by others, in most ordinary circumstances, in order to develop important ecological concepts. The animal species used for examples in these lessons were native and plentiful—owls, quail, deer, and pheasant. Their dilemmas were conflicts between the encroachment of human occupancy and lack of human knowledge about the needs of wildlife

Implications and Suggestions

The findings for this study have implications in various fields. This section includes implications for three groups: (a) educators, (b) researchers, and (c) policy makers.

Educators

This study was initiated to strengthen environmental education practices by examining historic models. As a practitioner in the field of environmental education, the researcher is disappointed with the lack of initiatives and support that environmental education received, in both formal and informal settings, in recent years. In addition, many of the environmental education activities that have been utilized since the formal embodiment of the field of environmental education in the 1970s lacked theory behind the practice. Activities were based around ecological concepts, but there was little information for educators to grasp about the underlying themes.

By the 1990s, environmental educators solidified the important concepts for ecological understanding by recommending the Four Strands for Environmental

Education (NAAEE, 1999). Unfortunately, education theory and practice turned its back on successful models that encouraged a systems approach to learning and returned to an archaic practice of “teaching to the test.” This disregard for the physiological and unique potential of individual creativity has increased the neglect and potential for the skills necessary to solve the massive environmental problems that continue to mount.

Leopold encapsulated environmental problems through creating models of significant events that contributed to the problems. He could “sift through the infinite debris of human experience to find answers to questions of ‘why’ and ‘how’ ”(Kavanagh, 1998, p. 5). The Case Histories and Animal Biographies were stories about authentic examples of environmental problems and events. The use of stories for classroom lessons are the most basic lessons for achieving human understanding and knowledge (Bowers, 1995; 1998; Eibl-Eibesfeldt, 1989; Ellen & Fukui, 1996).

Unfortunately, stories found within the scope of natural history have all but disappeared on college campuses (Krupa, 2000). Physical experiences with nature are the most elementary way to understand the complex ecological systems yet there lacks support for field trips and outdoor studies from the college to the pre-school level. The fundamental knowledge of basic nature identification is not valued and scientific interest has dwindled down to microscopic studies. Little emphasis is placed on the importance of local, native species, which, in reality, support ecological health for the community. As a result, the nature of science (Mestre, 2002) is poorly understood and students fail to understand or appreciate their personal association with the living, organic world outside their window.

The nature of science is ecological knowledge that is realistic, holistic, shared, and connected with other living organisms. An ecological world is patterned, not linear, where living systems are nested and organized through networks and relationships (Capra, 1999; Margaulis & Sagan, 1997). Educators must attend to vocabularies that support ecological ideals, and discard vocabularies that support sexism, racism, and intimidation because these vocabularies destroy ecological principles (Bowers, 2001; Fukui, Eibl-Eibesfeldt, 1996). Unfortunately, institutions of education are slow to respond for implementation of ecological knowledge.

University professor David Orr (1998) described the actions of universities to address today's environmental problems as "lethargic" (p. 15). It is imminent for universities to direct the education of students as citizens of a global, ecological community. Perhaps one of the first areas to help inject environmental standards for education is through the accreditation process. The accreditation process for universities is for the (a) enhancement of the educational quality throughout the region and, (b) to meet standards that address the needs of society and students (Commission on Colleges, 2008). The accreditation process should include the environmental needs of society today as a standard of practice because universities are institutions of liberal education.

As institutions of liberal education (Newman, 1999), universities are obligated to address the needs of society and their students by creating a free and autonomous individual for citizenship in a democracy (Fallis, 2007; Goldfarb, 1998; Gutman, 1999). The social contract between the university and a democratic society implies that universities have the responsibility to train professionals with the capacity to solve problems and pass on shared culture for the future (Fallis, 2007).

The enormous complexity of environmental problems has been ranked as high priority (Coyle, 2004), yet universities have done little to embrace environmental course requirements as a part of standard curricula (Kormondy & Corcoron, 1997). The historic model from this study can be used as an example for infusing ecological concepts for a multi-disciplinary approach in course curricula.

Leopold used local ecological models that engaged students with local community issues. Community engagement has been identified by the Carnegie Foundation (University of Louisville Office of Community Engagement, 2008) as an important framework for building strategies to strengthen collegiate assessments and accreditations. Community engagement coupled with environmental problem solving prepares college graduates to face the challenges in their prospective career fields as citizens in a global society.

Some states have in place recommendations for the integration of environmental education and community engagement on college campuses. The master plan for Kentucky (KEEC, 1999) states: "No student should leave a Kentucky college or university without a basic understanding of the interaction of natural and socioeconomic systems. Both our ecological and our economic future depend on this understanding, especially among our leaders" (p. 9). Murray State University makes environmental education a required class for its educational requirements for teachers. Unfortunately, Murray State University is the exception rather than the rule.

Science methods courses in universities, designed to help teachers integrate science in the K-5 classroom, often overlook the application of environmental teaching methods for teachers. There are very few efforts directed in providing new teachers with

the skills to help them identify the local habitat, much less how to probe and investigate local environmental problems. The lack of teacher training in environmental education for K-12 classrooms, and the lack of cohesive college curriculums with an ecological emphasis, makes the possibilities of engaging young students as future environmentally responsible adults seem unlikely.

There are a few universities in the United States that are beginning to require an ecological approach to their curriculum requirements for the general education of all their students. For example, the University of California Santa Cruz has restructured its College Eight core courses for new students. Beginning the fall 2009 semester, all freshmen will be enrolled in a new core course titled “The Environment and Us” featuring interdisciplinary subjects from electrical engineering, earth sciences, ecology, and evolutionary biology that are intertwined in a five-unit writing course (UC Santa Cruz, 2009). According to the provost, Ravi Rajan, “the core course will give students a solid scientific and policy foundation for environmental citizenship” to foster an “entrepreneurial spirit that will empower students to help tackle and solve environmental problems” (p. 2).

Environmental Problem Solving scored high in Wildlife Ecology 118 and, according to current studies, there are a lack of good examples for teachers to implement in the classrooms. Leopold combined phenology with history, sociology, and biology to create Case Histories and Animal Biographies. Models today that engage students with their environments include those that encourage phenology activities, such as the United Kingdom Phenology Network (Woodland Trust, 2009), Monarch Watch (University of Kansas Entomology Program, 2002), and Journey North: A Global Study of Wildlife

Migration (Annenberg Media, 2009). The Leopold Educational Project (Pheasants are Forever, 2009) and the Aldo Leopold Foundation (n.d.) continue to offer programs that nurture Leopold's principles and encourage nature study. Ecological literacy programs at the Center for Ecoliteracy (Capra, 1999) interject creative energy into environmental activities. Other activities that empower environmentally responsible activities are those that get people immersed physically with the outdoors (Chawla, 1998; Sia, Hungerford, & Tomereck, 1985; Tanner, 1980).

Outdoor classrooms that include garden activities, wildlife habitats, and field investigations such as water studies, archaeological investigations, and geology explorations, as examples, contain physical activities that challenge the senses. They draw attention to the detail of the natural and cultural settings that bring a significant understanding of place and belonging. These challenges help to make experiences more significant and memorable (Challa, 1998; Sia, Hungerford, & Tomereck, 1985; Tanner, 1980).

The natural environment is a classroom in constant motion that changes and responds. Environmental education begins with young children, whose senses are "naturally" attuned to the outdoors; children are physically closer to the Earth and capture minute details of the network of plants and animals. The plasticity of the natural environment (Kuo, 1967) provides the mental and physical challenges for developing growth in human potential.

Ecological knowledge is embedded in the evidence of soils, rocks, and water. Leopold understood the importance of "seeing" the knowledge in the land and "reading" the chapters embedded in ecological evidence. Wildlife Ecology 118 contained lessons

of abuse but also demonstrated the dependence and interplay of species with each other. Models of nurture, support and cooperation are observable and prolific. Ethologists (Dugatkin, 1997, Goodall, 1971; Kuo, 1967) have demonstrated that cooperative behaviors prevail over time.

Nature provides the models of nurture, support, and cooperation. Interaction with nature on a day-to-day basis gives competency of understanding for living. Nurturing and cooperative behaviors guide actions of joy and purpose, and, as Nel Noddings (1984) so appropriately espoused, the purpose of education should be to find joy in life.

In summary I recommend the following:

- Preschool and elementary level children be exposed as much as possible to outdoor settings. Natural materials, such as leaves, twigs, rocks, dirt, etc., can be incorporated for classification. Gardening activities and non-vertebrates should be included as a part of the indoor setting. Children should begin phenology journals and record their seasonal observations by going on short walks around the schoolyard and neighborhoods. Outdoor classrooms should be a part of standard school curriculum and include gardens, weather stations, and study areas.
- Middle and high school students should research their community history about the people and agricultural or industrial practices from the past. Graphs, charts, surveys are available through local government and agencies that list soils, water tables, flora and fauna. Local history societies can pinpoint important events and activities. Students should visit local sites of historic and natural interest to determine preservation

and importance for the present and future. Special identification should be made of neotropical species that depend on the local community to complete ecological cycles. Students should identify the present cultural artifacts that are changing today's landscapes. For example, do cell phone towers alter or effect landscapes or biological species?

- College students should be engaged in environmental courses of authentic community environmental experiences that include stewardship practices. Students should be engaged in field trips that explore the local natural history with heavy emphasis on species identification and phenology.
- As universities move toward practices that include national standards, every effort should be made to include required environmental education classes as a part of the standard requirement for college degrees for all students. It is the responsibility of universities to prepare future leaders with the strategies necessary for future problem solving. Research in this study indicates that global, environmental problems will continue to require efforts of individual, environmentally responsible behavior for the successful future health of the Earth's ecosystem.
- Educators should be trained on various methods to integrate subjects for a cross disciplinary approach to environmental education. Educators need training in natural history methods, such as phenology, and local species identification to develop classroom lessons and curriculum that give the ecological knowledge necessary to protect local ecosystems. Professional

development activities are needed that encourage educators to experience environmental problem solving “out in the field.”

Researchers

This study began as a historic case study to identify teaching models that would engage more people into responsible action for environmental initiatives. There were few models for the researcher to follow when developing the theory and framework to conceptualize the study. There was little research in the field of environmental education on historic figures and there seemed to be little encouragement for a study of this nature. It was “out of the realm” for most typical educational research. Fortunately, the researcher found a mentor who embraced history and education and encouraged the researcher to complete the study.

The matrix and criteria for the Four Strands for Environmental Education was devised by the researcher and it is hoped that it will be challenged and tested in other venues. It became an interesting model to test against the Wildlife Ecology 118 concepts and lessons and in most cases, seemed practical and applicable.

When the study began in 2002, there was little research in the literature regarding historic models for environmental education; however the field of environmental history has emerged as a new venue. This field seems to be rapidly expanding and the researcher hopes that other educators will pursue historic models of environmental educational practices that will support educators and legislation that encourages teachers and students to explore nature in pursuit of environmental problem solving.

Policy Makers

Familiarity with community gives a perspective of understanding that derives for society a sense of identity. Thinking, knowing, and understanding the local community are social and historical experiences built upon daily routines that build specific relationships among tasks and objects, places, and events (Stonier, 1992). The rapid disappearance and destruction of landscapes undermines the principles of community knowledge that are fundamental to the genetic makeup of human potential. Current large scale destruction of diverse ecosystems results in a sterile, unchallenging environment that holds little complexity to provide for quality of life. Policy makers should strive to protect communities by preventing amoebic development that totally disregards the ecological principles that give sustenance for life support.

Local policy makers need to support efforts that include green spaces to protect native wildlife species and to build networks from the local to global levels to build empathy for declining biodiversity. Educational policy makers should include support that provides outdoor investigations and field trips as a part of standard curriculums for public education. Policy makers of all types need to recognize that physical environmental experiences that allow contact with nature bring significant changes in environmentally responsible behavior. Efforts should be made that bring decision makers to the actual site of environmental studies and problems to provide that physical understanding of what is taking place. Support for educational institutions should be directed to environmental education activities that strive to give citizens the knowledge and capacity that can direct sound choices for sustainable ecological practices.

Leopold used Wildlife Ecology 118 as a cross-disciplinary approach to engage people with ecology. He led people to various settings; he encouraged nature observations, phenology, and note-taking and provided examples of successful and not so successful models of government interventions on environmental problems. Leopold demonstrated how cultural artifacts, such as fences and roads, can bring small changes to a landscape and then lead to larger problems that result in ecological damage. He tackled enormous political obstacles, was sometimes defeated, but more often successful.

Wildlife Ecology 118 was an accumulation of experiences, stories, and activities that immersed students in efforts to protect quality of life. In *A Sand County Almanac*, Leopold recognized that even a mouse understands and respects the place that provides the essentials of sustainability. The metaphor of the “mouse” is an example for humans to emulate and accept with humility and membership in the ecological community.

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