

Naturalizing Sustainability Discourse: Paradigm, Practices and Pedagogy of Thoreau,
Leopold, Carson and Wilson

by

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ABSTRACT

Understanding complex and adaptive socio-ecological systems (SES) to deal with our most challenging and overlapping problems such as global climate change, biodiversity loss, and rising consumption rates requires sustainability theory that is commensurate with these problems' size and complexity. The received United Nations-based sustainability framework aims to achieve a balance among three pillars—economics, environment, and social equity—for today and for future generations. Yet, despite applying this sustainability framework for over a quarter of a century, the Earth is *less* sustainable, not more. Theoretical trade-offs between environmental conservation and economic growth have often reinforced business-as-usual practices and educational paradigms, and emphasized economic values over ecological limits.

How can the principles of foundational naturalists help clarify, enhance, and advance sustainability discourse? I propose that the principles of Henry David Thoreau (1817-1862), Aldo Leopold (1887-1948), Rachel Carson (1907-1964), and Edward O. Wilson (1927-), express a worldview that captures and integrates a range and depth of historical, normative, economic, ecological, scientific, and social values for a viable and applicable discourse of sustainability.

This analytical study relies on (i.) textual analysis and interpretation of four key naturalists and humanists, (ii.) analysis of secondary sources that illuminate their proto-ecological and sustainability principles, and (iii.) interviews with leading sustainability scholars. Because these thinkers integrate science and ethics, natural history and philosophy, ecology and society, and environmental and economic problems within a holistic worldview, I call them *systems naturalists*. Their transdisciplinary worldview of one holistic system, with economics subordinated to environmental limits, links important values from the natural sciences and the humanities. The writings and

examples of systems naturalists provide more robust historical sustainability principles that can help solve our most challenging SES problems by synthesizing a broad range of knowledge in the sciences, social sciences, and the humanities to inform sustainability paradigm, practices, and pedagogy.

For mommies, daddies and little men

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GLOSSARY

Adaptation: adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (UNFCCC, 2012).

Adaptive capacity: the ability of a system to prepare for stresses and adjust (Engels, 2011).

American exceptionalism: the notion that American's canonical commitments to liberty equality, individualism, populism and laissez faire somehow exempt from the historical forces that have led to the corruption of other societies; attributed to Alexis de Tocqueville circa 1831 (Koh, 2003). That America is qualitatively different than past European civilizations, and the product of Providence (Madison, 1998). *Syn*: *Hubris*, as defined by researcher.

Anthropocentric: human-centered approaches, which include both "strong" anthropocentric positions, i.e., usefulness in satisfying human consumer preferences, and "weak" anthropocentric or pragmatic positions which advance a more thoughtful and environmentally sensitive humanism argued to avoid the anti-environmental consequences of harshly utilitarian-style ethical positions regarding nonhuman nature (Minteer; 2003; Norton, 1985). *Syn*: *Humans-first*, *Instrumental*, and *Imperialistic* as defined by researcher.

Best practices: commercial or professional procedures that are accepted or prescribed as being correct or most effective (Oxford, 2012).

Biophilia: the innately emotional affiliation of human beings to other living organisms. 'Innate' means 'hereditary' and hence part of ultimate human nature. 2.) a complex

set of learning rules developed over thousands of years of evolution and human-environment (Beatley, 2011; Wilson, 1993).

Carrying Capacity: the maximum population (as of deer) that an area will support without undergoing deterioration (Merriam-Webster, 2013).

Cascading effects: a chain of secondary events that have complex and often unpredictable effects throughout ecological and socioeconomic systems (i.e., SES), as defined by the researcher.

Conservationist: in the narrow sense, a utilitarian and more *anthropocentric* perspective of the highest good for the highest number and use of environmental services in the public interest, as defined by researcher. (Also often used in the broader sense, such as Wilson's *conservation biology*.) *Syn: Imperialist* (Worster, 1994a), *Anthropocentric* (Minteer, 2003); *Economist* (Wilson, 1998).

Emergence/Emergent properties: the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems (Anderies, Jansen & Ostrom, 2004). Emergent phenomena are conceptualized as occurring on the macro level, in contrast to the micro-level components and processes out of which they arise (Goldstein, 1999). Emergent properties are phenomena that cannot be predicted from the components of the level or unit in ecological levels of organization. *Syn: Non-reducible property* (Odum & Barrett, 2005).

Environmental Externalities: the economic concept of uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost outside the market mechanism as defined by the Organisation for Economic Co-operation and Development (OECD). Granting the OECD's completely

instrumental view as a valid economic view, I balance this definition from a population ecologists' view, and William Rees's and Meidad Kissinger's (2010) rough definition of an "ecological externality" as "accelerating ecosystems degradation . . . associated with over-exploitation as global market forces increasingly assert their influence." Environmental externalities, even if fully internalized, would not capture the long-term damage to ecosystems (Kissinger & Rees, 2010).

Framework: a: a basic conceptual structure (as of ideas) *b:* a skeletal, openwork, or structural frame (Merriam-Webster, 2013).

Holism: a theory that the universe and especially living nature is correctly seen in terms of interacting wholes (as of living organisms) that are more than the mere sum of elementary particles (Merriam-Webster, 2013). [Often understood as the opposite of *reductionism*]. *Syn: Interconnectivity, Transdisiplanarity* (Klein, 1990), *Consilience*, (Wilson, 1998) as defined by researcher.

Ideology: 1a) a systematic body of concepts especially about human life or culture; 1b) a manner or the content of thinking characteristic of an individual, group, or culture (Merriam-Webster, 2013). 2) a pejorative term which means a sense of abstract impractical or fanatical theory popularized by Karl Marx and Friedrich Engels (Williams, 1973).

Induction/ Inductive reasoning: reasoning from specific to general conclusions (Odum & Barrett, 2005). As opposed to explicative, analytic, or deductive' and `amplifiative, synthetic, or (loosely speaking) inductive' reasoning. Charles Pierce characterized the latter as reasoning in which the facts summed up in the conclusion are not among those stated in the premises' (Pierce & Moore, 1998; Popper & Miller, 1987).

Naturalist: a student of natural history; especially: a field biologist (Merriam-Webster 2013). Practitioner who applies concepts from one discipline or field to the greater whole of epistemology (Wilson, 1998).

Non-anthropocentric: non-human centered approaches that include a) "Zoocentric" (animal-centered) positions; b) "Biocentric" (life-centered) positions; and c) "Ecocentric" (ecologically-centered) positions (Minteer, 2003). *Syn*: *Arcadian* and *Environmentalist*, as defined by the researcher.

Normative sustainability: does not view or treat human and natural capital as interchangeable; adaptive capacity; has an ethical imperative (Norton, 2005).

Preservationist: in the narrow sense, an intrinsic and more *non-anthropocentric* worldview, stemming from less progressive values of John Muir during the Pinchot-Muir controversy, as defined by researcher. *Syn*. *Arcadian* (Worster, 1994a), *Non-anthropocentric* (Minteer, 2003); *Environmentalist* (Wilson, 1998).

Reductionism: 1) an explanation of complex life-science processes and phenomena in terms of the laws of physics and chemistry; also: a theory or doctrine that complete reductionism is possible 1a): a procedure or theory that reduces complex data and phenomena to simple terms. 2) the attempt to explain all biological processes by the same explanations (as by physical laws) that chemists and physicists use to interpret inanimate matter; also: the theory that complete reductionism is possible; 2a) a procedure or theory that reduces complex data or phenomena to simple terms (Merriam-Webster, 2013).

Resilience: Capacity of a system to absorb disturbance and still retain its basic function and structure (Walker & Salt, 2006).

Socio-ecological system (SES); SES problems: an ecological system intricately linked with and affected by one or more social systems (Anderies et al., 2004); coupled human-environmental systems (Young, Berkhout, Gallopin, Janssen, Ostrom & van der Leeuw, 2006). A suite complex, global, multilevel, cross-temporal and *emergent* problems (Anderies et al., 2004), which will drive decision-making. Syn: *Super-Wicked Problems* (Levin, Cashmore, Bernstein & Auld, 2012) as defined by researcher.

Systems naturalist: a naturalist who represents many of the values of linking natural and material sciences with the social sciences and philosophy; a fuller and transdisciplinary sense of holism. Beginning with material findings and proceeding through induction to philosophical theories, as defined by the researcher.

Threshold: a limit in a socio-ecological system, that when crossed, the system begins to change and feedback with its component parts and a different structure so that it enters into a new regime, i.e. “changing too much” (Walker & Salt, 2006).

Trade-off negotiating: [in sustainability discourse] seeking mutually reinforcing, cumulative and lasting contributions and must favor the achievement of the most positive feasible overall result, while avoiding significant adverse effects (Gibson, 2006).

Transdisciplinary: fully integrating all the branches of learning in order to solve a problem; preferred to multi- or inter- disciplinary (Odum & Barrett, 2005). Education that reflects and aspires to a complete unity of knowledge systems (Wilson, 1998).

Vulnerability: the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (UNFCCC, 2012). *Ant*: *Robustness*.

Weak Anthropocentrism: a more thoughtful and environmentally-sensitive humanism that seemed to avoid the anti-environmental consequences of harshly utilitarian-style ethical positions regarding nonhuman nature (Minteer, 2003; Norton, 1985).

Wicked/Super-wicked problems: problems of such complexity that they require the integration of knowledge from many disciplines coupled with experiential and empirical knowledge from practitioners in the field (Kates & Parris, 2003; Brown, Harris & Russel, 2013). Super-wicked are wicked problems where the time available to solve such problems is running out and there is no “testing ground.” *Syn*: *Socio-ecological problems*, as defined by the researcher.

Worldview: the fundamental cognitive orientation of an individual or society encompassing the entirety of the individual or society’s knowledge and point of view, including natural philosophy; fundamental, existential, and normative postulates; or themes, values, emotions, and ethics (Palmer, 1996). *Syn*: *Paradigm*, (Oxford, 2014).

CHAPTER 1: INTRODUCTION

We live in times of great uncertainty and complexity, both of which are reflected in our society and in nature. Population ecologists William Rees and Mathis Wackernagel (1996; 2013) argue that we have likely surpassed *carrying capacity* (or the maximum population) the Earth's systems can support without deteriorating (Kates & Parris, 2003), as well as irreversibly converting natural resources into energy and economic resources that cannot be replenished (Schneider & Kay, 2014). Moreover, human-caused problems like global climate change, biological diversity and soil loss in many ecosystems, and rising population and consumption rates collectively have a multitude of cascading effects for humankind and ecosystems alike, which threaten the survival of life on the planet (Erhlich, 1988; Wilson, 2002).

Such potentially catastrophic problems have particular implications for sustainability theory, sustainability practices, and sustainability education (EfS),¹ which must integrate a spectrum of knowledge from the natural sciences, social sciences, and the humanities—also known as the “three branches” of education. *The Brundtland Report* (1987) has provided a model for this in the “three pillars” of sustainability (i.e., society, economics, and environment). But the elemental construction of the Brundtland paradigm does not capture the complexity of these socio-ecological problems. In addition, it has been criticized as providing a basis for incremental, instrumental, and efficiency-based approaches to coupled human-natural systems, which work not to sustain resources but rather to diminish carrying capacity (Grober, 2012; Hallet, 2012; Newton & Freyfogle, 2005; Owen, 2012).

¹ EfS (Education for Sustainability), contrary to ESD (Education for Sustainable Development), has a stated focus on transforming university curriculum (Mudler & Jansen, 2006). This is contrasted with the ESD's “bolt-on” approach which requires “minimal change to curricula in universities” (Thomas, 2009, p. 247) and discussed in full in “Chapter 12: A Systems Naturalist Curriculum.”

Global and local environmental degradation, together with steadily increasing levels of human population and consumption, are presenting unprecedented tests and trials for the maintenance of global *socio-ecological systems* (SES). Anderies, Jansen & Ostrom, (2004) have defined SES as “an ecological system intricately linked with and affected by one or more social systems.” Many sustainability leaders (Young et al., 2006) have called them simply “coupled human-environmental systems.” Unlike engineered systems, “SES are never fully designed or controllable,” but rather “emergent” and “self-organizing” (pp. 3-5). Anderies et al. (2004) also stress a crucial point for today’s efficiency-based sustainability thinking: “robust” and “resilient” systems are less prone to vulnerability and shocks. Affected by external or internal influences, are not likely to be as efficient as “non-robust” systems, and are primarily based upon and defined by long-term performance-based criteria (p. 4).

While developed nations tend to improve the quality of their “local” environment, they also tend to consume more and more “global” resources, often from developing nations (Boutaud, Gondran & Brodhag, 2006). Ferng (2014) has argued that living within the global carrying capacity would mean a radical transformation “from the prevailing human-demand-oriented consumption mode to the land-supply-oriented consumption mode” (p. 108). But few studies have been performed to integrate global carrying capacity with economics (Rees, 2006); and, while SES theory has been applied to many open system areas, it has not been applied to the closed system of the ecosphere. This fails to adhere to logic, because as population ecologist Rees (2006) argues, global sustainability is “a prerequisite for everything else” (p. 221).

Where do we even begin to solve the enormous SES challenges we face today? In pursuing a viable answer to this question, traditional naturalists have largely been overlooked. In this dissertation, I posit that leading American naturalists have long

expressed skepticism toward incremental, instrumental, and efficiency-based approaches to coupled human-natural systems that lead to diminished carrying capacity. The *Brundtland Report* (1987) and other UN publications have provided only one somewhat arbitrarily constructed model for integration, and the naturalist tradition has continuously studied the interface of nature and culture through its envisioning of *holism* or *synthesis* (Walls, 1995; Wilson, 1998; Worster, 1994a).

Traditional naturalists have understood holism much like the “first naturalist” Aristotle, who unified fields as diverse as biology and ethics, physics and poetry, and evolution and society. He famously stated in *Metaphysics* that,

[T]he truth seems to be like the proverbial door, which no one can fail to hit, in this respect it must be easy, but the fact that we can have a whole truth and not the particular part we aim at shows the difficulty of the whole, meaning the whole is more than the sum of its parts. (Aristotle, 371 B.C./2004, p. 36)

Aristotle’s third-century BC holistic view is similar to today’s definition of holism.² His sense of all knowledge being related represents a worldview that is not necessarily “mystical,” and “top-down” as in a Christian or divine plan as some have suggested (Norton, 1991, p. 180), but instead it comprises a paradigm of interdependency—where each part contributes to the whole—and a means of working toward “synthesis” among the different branches of knowledge (Klein, 1990; Wilson, 1998; 2015). This was the common method to study “the meaning of humanity by the laws of science,” or “natural philosophy” until the second half of the nineteenth century (Wilson, 1998, pp. 59, 73, 91-3, 292-294; Wilson, 2014, p. 38). Before examining any particular naturalist’s idea of holism, however, we must first define precisely what a *naturalist* is.

² “The theory that parts of a whole are in intimate interconnection, such that they cannot exist independently of the whole, or cannot be understood without reference to the whole, which is thus regarded as greater than the sum of its parts” (Oxford, 2014).

The term *naturalist* has changed over time (Williams, 1973). During the height of its use in the seventeenth and eighteenth centuries, it denoted, first, a field biologist engaged in direct observation and experimentation, and second, a natural philosopher or student of natural history (Farber, 2000; Worster, 1994a; Wilson, 2014). The word “scientist” was not coined until William Whewell’s (1794 – 1866) dictionary in 1840 (Worster, 1994a, p. 130).³ Cultural theorist Raymond Williams (1973) noted that in the early nineteenth century, in the era of Henry David Thoreau (1817-1862), a “naturalist” was synonymous with a “scientist,” and “in practice those whom we would call physicists or biologists” (p. 216).

Cultural theorists (Williams, 1973), historians (Farber, 2012; Worster, 1994a), biologists and socio-biologists⁴ (Wilson, 2012), and experts on the history of science (Yeo, 2003) have defined a third aspect of the naturalist—a holistic worldview—that imbues the term *naturalist* with its most crucial aspect for sustainability thinking. It is this holistic worldview tradition within the context of key naturalists from the American environmentalist tradition that I intend to explore in this dissertation.

Most importantly for sustainability discourse, naturalists are, more often than not, systems thinkers. Possibly because of their knowledge of natural history—or their view of humans as natural and part of nature rather than separate from it—the most comprehensive, inclusive, and far-reaching naturalists systematically applied their direct observations of the natural world to larger theories of the three branches of sustainability

³ Whewell also wrote several books about induction—*The Philosophy of the Inductive Sciences, founded upon their history*, in 1840; and *Of Induction, with especial reference to Mr. J. Stuart Mill's System of Logic*, in 1849. Whewell’s dictionary that also added the word “scientist” for the first time (previously many scientists by today’s definition were naturalists. It also is the source of Wilson’s (1998) notion of *consilience*, which Whewell also coined and defined as a “jumping together” of knowledge (p. 8).

⁴ Socio-biology is “the comparative study of the biological basis of social organization and behavior in animals and humans especially with regard to their genetic basis and evolutionary history.” (Merriam Webster, 2014). Edward O. Wilson has fully developed this concept in theories of genetic and social coevolution in *The Social Conquest of the Earth* (2012).

(including economics). They used probable and creative reasoning based on a synthesis of the general premises of many disciplines, which can be understood as *inductive reasoning* (Popper & Miller, 1987; Walls, 1995; Wilson, 1998; Yeo, 2003). The most influential of these naturalists have applied findings in their “specialties” to the larger body of knowledge as a whole, including disparate fields such as economics, philosophy, and the sciences, using analysis and synthesis to refine their methods and applications.

Naturalists therefore are often not characterized as reductionists. Additionally, their principles are often aimed at how epistemology (the theory of knowledge and its method) works as a whole, spanning the three branches. The work of systems-thinking naturalists includes many humanist elements in history, ethics, philosophy, literature, and the arts. Such elements, however, are often ignored when interpreting and addressing today’s most complex SES problems. For example, narrowly focused disciplinary tracts of most universities often fail to integrate key disciplinary principles (Wilson, 1998). The naturalists’ holistic approaches and synthesis provide a more creative and frontier-of-knowledge aspect, as well as contributing a much-needed broader focus based on the “unity of knowledge,” (Wilson, 1998, pp. 29, 35, 105) “in order to understand complex systems” (p. 292).

This dissertation focuses on four influential naturalists from the four eras of the American environmental tradition—Henry David Thoreau (1817-1862), Aldo Leopold (1887-1948), Rachel Carson (1907-1964), and Edward O. Wilson (1927-). These thinkers helped shape the foundations of ecology, conservation, and the U.S. environmental movement. The writings of these canonical scientists, early ecologists, holistic thinkers and enlightened environmentalists display the integration of numerous disciplinary fields (Worster, 1994a).

Throughout this dissertation, I refer to these ur- and proto- sustainability thinkers as *systems naturalists*,⁵ since their concepts, values, and principles capture and integrate a remarkably heterogeneous range and depth of historical, normative, economic, ecological, scientific, and social values central to a viable discourse in sustainability. Different systems-naturalists from different eras of our cultural and environmental history help place current sustainability and SES challenges into perspective. Many current and local-to-global SES problems such as climate change, biodiversity loss, and rising consumption rates have a long cultural and natural history from which to draw and learn. An intellectual history of sustainability problems and systems-thinking contains the roots of both the problem and the solution. Since today's thinking often replicates past assumptions about knowledge and value in the sciences and the humanities (i.e. the three branches), historical systems naturalists can help overcome aspects of these inherited problems.

Our greatest SES challenges call for an informed sustainability discourse commensurate with their magnitude, complexity, and integration (Kates & Parris, 2003). I assert that the intrinsic ability of these unique ecologists, writers, activists, and thinkers to view the Earth, its ecosystems, and its inhabitants (human and otherwise) as a single, integrated system preserves the Aristotelian tradition of integrating myriad disciplines. This synthesis provides a framework more comprehensive and capacious than the three pillars, and it presents an apparatus commensurate with what is required to solve the magnitude of today's SES problems.

In the rest of this introductory chapter, I discuss the research problem as characterized by the inherent ambiguity and contradictions contained in the term

⁵ Rather than use a loaded term like “holistic naturalists” or an awkward term like “sustainability naturalists,” I chose “systems naturalist.” My intent is to describe the natural-human interface of systems thinking as *one* thing, *one* coupled system.

sustainability (Newton & Freyfogle, 2006; Parris & Kates, 2003), and the theoretical background of SES and sustainability. Following this discussion, I briefly outline the methodology of the dissertation, highlighting naturalists' contributions. Finally, I explore the implications for sustainability discourse and SES problem solving through three broad and overlapping areas of sustainability discourse:

- 1) the sustainability paradigm (deep sustainability theory), an integration of scientific and ethical traditions from cultural and environmental history for coupled-systems worldview;
- 2) sustainability practices, an integration ecology and the life sciences with economics and ethics to bridge theory and practice;
- 3) sustainability pedagogy (sustainability educational theory), an integration of science and ethics, theory and practice that captures disciplinary subtleties in the university and in the local-to-global community.

Overview of the Problem

This background discussion begins with a detailed explanation of SES and its import to sustainability discourse, highlights the deficiencies of the received framework for sustainability, and focuses on the omission of naturalists in the current sustainability paradigm, practices, and pedagogy. *Socio-economic* problems afflict developed and developing regions alike: widening income disparity, abysmal educational disparities, high levels of poverty, and rapidly growing urban populations, just to name a few (Beddoe et al., 2008; Munang, Thiaw, & Rivington, 2011).

As significant as these problems are, there are parallel SES problems that increasingly threaten the integrity of the global life-support systems that underpin every social and economic system. Furthermore, much of the global North's *ecological footprint* (EF)—the amount of natural resources needed to support a human

population—is externalized beyond their borders, depleting arable resources, and causing global biodiversity depletion (Kissinger & Rees, 2010; Kates & Parris, 2003). Although many developed countries have recently improved their local environments, they continue to increase their ecological footprint, causing an increased dependency on an expanding market for economic commerce.

By 2050 the US population will exceed 400 million (Kotkin, 2010). The world’s population will approach 9 billion (IPCC, 2014), rising exponentially in some developing countries. While in 1798 Thomas Malthus was possibly the first to examine questions of global carrying capacity—and this concept has been expounded upon for at least forty years in documents like *Limits to Growth* (1972)—this important concept rarely intersects with actual planning practices and sustainability education at present (Newman & Jennings, 2008).

The contemporary concepts of sustainability and sustainable development—as well as the need for such concepts—evolved from the spectrum of the sciences, social sciences, and humanities, suggesting that each individual intellectual branch lacked the capability to solve rapidly surfacing social and environmental problems by its singular disciplinary methods alone (Kates & Clark, 2012). While sustainability discourse has made great strides since first introduced in United Nations (UN) literature during the 1970s and 1980s, such methods have yet to make the Earth more sustainable (Adams, 2006). Thus, the current UN-based framework for sustainability is inadequate in application to the size, magnitude, and complexity of the problems at hand (Hopwood, Mellor & O’Brien, 2005; Holling, 2001; Kates, Parris & Leiserowitz, 2005; McKibben, 2009; Newton & Freyfogle, 2005; Jamieson, 1998; Norton, 2005; Solow, 1993; Vucetich & Nelson, 2010).

SES Problems

SES theory may seem revolutionary and SES problems may seem new; but SES thinking began at least 50 years ago and the problems themselves are as old as civilization (I discuss the latter in more detail in Chapter 4). The general awareness of coupled systems and diminishing carrying capacity reaches back at least as far back as the 1960s and 1970s, particularly in the work of ecologist and systems-thinker C. S. Holling (1973), and in the findings by international and interdisciplinary groups such as the authors of the *Limits to Growth* (Meadows et al., 2004). Intensely complex socio-ecological problems (like global climate change, biodiversity loss, and rising consumption rates) that lower the natural carrying capacity on global, regional, and local scales have been characterized as *wicked* problems, denoting the requirement of a new and significantly more capacitated mode of thinking for their resolution (Rittel & Webber, 1974). Urban planners and science of design experts Horst Rittel (1930-1990) and Melvin Webber (1920-2006) used the term *wicked problems* concept in 1973 to define such seemingly confounding dilemmas in a general theory of planning.⁶ They described such problems as being so complex that a new, arduous level of problem solving was required. At that time, no one yet knew what those problem-solving skills entailed. Examples of wicked problems include climate change, healthcare, the AIDS epidemic, international drug trafficking, nuclear weapons, nuclear energy and waste, and social injustice. Today, we realize these types of problems demand the integration of knowledge from many disciplines coupled with experiential and empirical knowledge from practitioners to address them (Brown, Harris & Russel, 2013; Kates & Parris, 2003; Klein, 2006; Rittel & Webber, 1974). The challenge, which speaks to the special skills of

⁶ Urban planners and science of design experts Horst Rittel and Melvin Webber used the term “wicked” first in “Dilemmas in a General Theory of Planning” (1973). The concept was actually introduced to Webber by a student regarding the moral conundrums arising from an air pollution study in 1970.

naturalists, is “that what is often divided into natural and human systems be considered a single, complex socio-ecological system” (Redman, Grove & Kuby, 2004).

Other principles intersecting with SES also have their origins in the 1960s and 1970s. During this period, Holling’s work also introduced the highly useful terms *adaptive capacity*, *resiliency*, *transformability*, and *transdisciplinarity* that I employ in this dissertation (Anderies et al., 2004; Holling, 1969; 1973; 2001; Resilience Alliance, 2014; Walker et al., 2004). Adaptive capacity and resiliency regard the particular dynamics of a situation (Walker et al., 2004); the former describing the ability of a system to prepare for stresses and adjust (Engles, 2011), and the latter the ability of a system to bounce back without significant changes. Transformability “refers to fundamentally altering a system” (Walker et al., 2011, p. 5). Finally, transdisciplinarity is the full integration of the “three branches” (e.g. the sciences, social sciences, and humanities) and the linking of theories and practices that informs sustainability thinking (Crow, 2012; Odum & Barrett, 2005). Holling (1973) observed that to understand ecology, we needed to comprehend an understanding of dynamic and shifting stable-states that could have little resemblance to one another, and that this could also be applied to wicked and SES problems.

If wicked problems were not daunting enough, some SES problems have been designated as *super-wicked* (Levin et. al., 2012), given that the time available to solve such problems is limited; and there is no “testing ground”—meaning they cannot be solved by trial and error given that we only have one planet on which to experiment. Peak oil, soil depletion, loss of biodiversity, growing urban squalor, and twenty-first century global traumas/crises such as the Fukushima disaster are just some of the highly complex problems vexing our institutional abilities to anticipate and respond effectively—especially over the long-term (Newman, Beatley & Bower, 2009).

The key to dealing with wicked and super-wicked SES problems lies in understanding *coupled human-natural systems* (CHANS), which are synonymous with SES (Anderies et al., 2004; Kates, Travis & Wilbanks, 2011; Liu et al., 2007). Parris and Kates (2003) have described the most pressing SES problems as those that decrease carrying capacity.⁷ Our most challenging SES problems must be approached by integrating knowledge systems that cross normal disciplinary boundaries with a worldview and associated value frameworks that transcend or transform traditional ideas of how to simplify the complex spectrum of knowledge without being overly simplistic or relying on a smattering of knowledge from each discipline, or the hegemony of one discipline (Klein, 1990; 2006; Wilson, 1998; 2014).

Contemporary SES Problems and Sustainability Thinking

The Proceedings of the National Academy of Sciences (PNAS) has recognized SES as inextricably intertwined with the emergence of a new transdisciplinary science, or a study that integrates all the branches of learning—*sustainability science* (Kates and Parris, 2003). SES research that discusses issues of global carrying capacity has been expanded upon in recent years by sustainability scholars such as Kates and Parris (1999; 2003) and William Clark (1999; 2007), who have highlighted mass poverty, the collapse of fisheries, and problematical ecological, economic issue, and environmental justice issues created by urban development to include megacities (populations of 10 million), with a substantial portion of the population living in urban squalor. Clark has worked with Kates and others (Chapin et al., 2010; Clark et al., 2010; Kates et al., 2000) investigating ecosystem diminution, agricultural erosion and depletion, and biodiversity losses, issues that—along with climate change—are among sustainability’s most urgent

⁷ Carrying capacity is defined very similarly to Parris and Kates (2003) (see dissertation p. 1) by the *Oxford Online Dictionary* (2014) as “the number of people, other living organisms, or crops that a region can support without environmental degradation for human and nonhuman species alike.”

problems. These thinkers advocate for the resiliency, adaptive capacity, anticipatory governance, and transformation of current systems rather than relying on the more one-dimensional concept of efficiency-based sustainability. This framework is now returning to a *Limits-to-Growth* vision and has now developed an enhanced set of literature, but it is one that is rarely employed in sustainability planning (Rees, 2006).

Forecasting through statistical modeling using increasingly nuanced variables, such as modeling developed under the name Complex Adaptive System Science (CASS) (Woollard & Rees, 2000; Yu, 2001) is often thought to be the basis for sustainability science today. Yet, we may want to consider that, thus far, scenarios and statistics alone have performed poorly in painting a compelling picture when addressing issues such as how to link science and ethics, economy and ecology, and cultural and natural history. A more humanistic, emotional, and ethical, as well as scientific and ecological framework is needed for the survival of the human and natural world, and can be provided by the discourse of traditional naturalists, but so far this tradition has been largely overlooked.

Naturalists: A Gap in Sustainability Literature

In general, sustainability science and SES research does not refer directly to the naturalist tradition, a function, perhaps, of a larger manifestation of the traditional downplaying of historical trends within these fields and the tendency to emphasize statistical forecasting and prospective scenario-building (Brown, Harris & Russel, 2013; Redman Wiek & Johnston, 2013). Sustainability research by even our most respected sustainability scholars, in fact, typically only incorporates the naturalist tradition in a superficial and aspirational fashion, (e.g., by offering a few inspirational lines discussing naturalists' "sense of wonder" or "spirituality") (Andrews, 2005; Hawken et. al., 2005; McDonough & Braungart, 2006).

Of the major sustainability literature from Kates, Clark, Ostrom, Redman, Folke and Wiek, only the article “Coupled Human Natural Systems” co-written by a team of writers including Ostrom and Redman (Liu et al, 2007), mentions systems naturalists by briefly referring to the Aldo Leopold Foundation. More often than not, leading sustainability scholars provide no (or cursory) mention of the naturalists. Furthermore, sustainability literature has not begun to mine the full range of naturalist contributions to these fields. Although writers from many disciplines have explored the major figures examined in this dissertation, few have done so through the lens of sustainability.

A case in point is sustainability education leader Andres Edwards’ *Sustainability Revolution: Portrait of a Paradigm Shift* (2005). Highlighting the changes in worldview brought about during the twentieth century, the author mentions naturalists once, and then only as writers who “pointed to the significance of nature as a mystery full of symbols and spirituality” (p. 12). Remarkably, other accounts are even less satisfying. In his 2011 book *The Conundrum: How Scientific Innovation, Increased Efficiency, and Good Intentions Can Make Our Energy and Climate Problems Worse*, David Owen, a leading sustainability author who focuses on the benefits of urban planning, mentions only Rachel Carson, saying that she “inspired” the environmental movement with a book about pesticides (p. 17). Other than that brief mention, Owen avoids the naturalists and the substantial contributions of their writing in his work altogether.

Consider, too, the environmentalists and techno-optimists who advance the concept that all growth can be achieved within greater efficiency measures alone such as Amory Lovins’ and Paul Hawken’s influential book *Natural Capitalism; the Next Industrial Revolution* (2005). In spite of claiming that their theories are “built upon the groundbreaking work of Aldo Leopold, Rachel Carson, and Wendell Berry” (p. ix), the authors do not mention any of the naturalists’ ideas on economics. Furthermore, they

only vaguely reference Leopold's "Thinking like a Mountain" (1949) in their discussion of systems thinking.

While the above sustainability scholars largely neglect the naturalists, others saddle the tradition with misguided criticism. Research by sustainability writers Ted Nordhaus and Michael Shellenberger (2004; 2007) have condemned naturalist worldviews for being unnecessarily alarmist, and arguing further that naturalists "depend too much on the visual" in their description of pollution and reminiscing about a lost time when people lived in harmony with nature (2007; p. 25). In addition, writers like Daniel Botkin (1990), Michael Pollen (1991), and Mark Sagoff (1997) have used naturalists to defend their argument that humans need to control and recreate nature, "molding it humbly but nonetheless forcefully to create the world they prefer" (Newton & Freyfogle, 2005, p. 28).

Even our most profound chemical and engineering designers of the new sustainability society, William McDonough and Michael Braungart, in their widely read work on industrial ecology, *Cradle to Cradle: Remaking the Way We Make Things* (2006), refer to Thoreau, Leopold, and Carson superficially by only acknowledging their "romantic strain" as those who loved the environment and "lamented its destruction" (p. 34). Only Holling refers to Leopold regularly, starting in 1959 to discuss emergent properties, land health and regime shifts.

Each of the systems naturalists in this dissertation, however, has devoted scores of pages to science and ecology, to government and economics, to ethics and aesthetics. Of the many contemporary sustainability and systems thinkers, I posit that this systematic neglect and exclusion of naturalists within the sustainability agenda has been, and remains, detrimental to the field.

Systems Naturalists and Sustainability

Because their holistic worldview encompasses the sciences, social sciences, and humanities, systems naturalists understand the importance of linking economic and environmental practices to preserve resources for the long-term. Awareness of natural and cultural history and the use of deductive *and* inductive reasoning unite common threads within interdisciplinary thinking, enabling naturalists to consolidate premises and principles of disparate fields of inquiry (Walls, 1995; Wilson, 1998). Finally, systems naturalists link advances in science, ecology, and technology to advancements in the understanding of morals and ethics that can inform a fuller environmental education that incorporates regard for the natural world. Their work can fill knowledge gaps in the current sustainability discourse to help resolve its growing complexity. I posit that a deep exploration of these four systems naturalists and their contributions can be used both to enhance and advance sustainability discourse.

Although the three pillars have guided sustainability planning around the world, economists have overly influenced them. William Rees (2006) argues:

In recent years a wish list of allegedly desirable socio-economic goals has come to dominate sustainability discussions at the expense of even shallow environmental factors. This is unfortunate because it diminishes the role of the most fundamental dimension of the sustainability conundrum—a stable, productive ecosphere remains prerequisite to everything else. (p. 221)

Systems naturalists, on the other hand, have a long tradition of examining SES problems from a much fuller approach that engages personal, ecological and historical perspectives.

Organization of Dissertation

This introductory chapter has established the potential importance to sustainability thinking of naturalists as holistic, transdisciplinary, and coupled systems thinkers. In “Chapter 2: The Import of Systems Naturalists,” I further introduce the four system naturalists in detail, plus recent research of naturalists in the humanities, a brief overview of the methodology, and some of the implications for sustainability discourse.

In “Chapter 3 and 4: What is Sustainability?” (parts 1 and 2), I examine intellectual thinkers and historical influences on the term sustainability that shaped the accepted or received notions of sustainability, as the concept grew in familiarity during the 1970s and 1980s in the international development discourse as framed by the UN. An alternative tradition for sustainability, however, can be found in the history of SES problems, and early interdisciplinary systems thinkers who contributed to the foundations of concepts like carrying capacity, stewardship, and social and environmental activism.

Both the received and alternative sustainability traditions exhibit a type of holism that helps position the system naturalists in Chapters 5-10. The alternative tradition, however, is built on the views of scientists and thinkers very concerned with the earth as an ecosystem and the threat of further surpassing carrying capacity, as well as the challenges of similar SES problems as today. This will set the stage for later discussions on how embracing the systems naturalist worldview can help facilitate the creation of a framework centered on planetary survival instead of sustained yield or economic growth.

In Chapters 5 and 6, I describe the systems naturalists’ worldview of coupled-systems for an advanced and transformative sustainability paradigm. These draw upon the writing of Thoreau and Leopold to help reshape sustainability’s deep theory. “Chapter 5: Integration of Human and Natural Systems (Principle #1)” examines

principles from Thoreau that ground our philosophy and ethics in the natural sciences.

This includes:

- i.) the study of natural philosophy, and the understanding that the relationship between human beings and nature changes with the understanding of natural and cultural history;
- ii.) the combining of physical and philosophical knowledge, rather than a Cartesian dualism paradigm; and
- iii.) the forwarding of knowledge through a complementary scientific method, including both inductive and deductive reasoning as complementary and necessary.

Next in “Chapter 6: A Paradigm of Interdependency (Principle #2),” I employ Leopold’s principles to uncover how systems naturalists forwarded an ethic of interdependency that emphasizes:

- i.) interconnectivity, rather than the traditional view of hierarchical relationships placing God and “Man” above all other species;
- ii.) ecological roles and functions over abstract and idealistic forms of nature;
- iii.) stewardship over the traditional worldview of Providence, and a static natural world under divine control; and finally,
- iv.) challenges to perpetual economic growth models with ethical and ecological truths.

In Chapters 7 and 8, I explore how system naturalists link ecological and economic systems. In sustainability-practices chapter, “Chapter 7: Absorbing Environmental Externalities (Principle #3),” I examine how Carson and Wilson rally around balancing economics with science and ethics, in order to:

- i.) expose the external costs associated with the exploitation of natural resources;
- ii.) argue for scientists to be involved in the economy; and
- iii.) balance ecological and technological sciences.

Second, “Chapter 8: Economic Practices within Ecological Limits (Principle #4),” I look at how Thoreau demonstrates:

- i.) that unregulated capitalism has not historically provided health and well-being for people or ecosystems;
- ii.) that our neoclassical economic system has alienated humankind and nature alike; and
- iii.) that building an economic system by creating an economy which uses less, and is need-based, is more fulfilling than classical and neo-classical economies.

Chapters 9 and 10 turn the focus to sustainability pedagogy. They discuss how we must view education in terms of an epistemological spectrum and teach strong “holistic” sustainability thinking skills over efficiency and incremental models. In “Chapter 9: Normative Sustainability Education,” I argue for teaching normative sustainability (as exemplified by Leopold) over weak economic and efficiency-based models, by centering sustainability education on:

- (i.) normative sustainability’s foundation in the field of ecological science;
- (ii.) normative sustainability’s maintenance of socio-ecological system resilience;
- and
- (iii.) normative sustainability’s theory of social and ecological integrity.

In “Chapter 10: Transdisciplinary Education,” finishing the body of systems naturalist principles, I argue that in order to develop integrative and transformative

sustainability education, we must follow Carson's and Wilson's understanding in order to:

- i.) view sustainability education as an epistemological spectrum;
- ii.) employ sustainability as a critique of science and technology; and
- iii.) combine fields that are traditionally eco-centered and human-centered.

In Chapter 11, I first examine previous EfS and ESD educational theory studies, discuss sustainability competencies and goals, and I then describe the objectives, units, and framework of a course that integrates the works of systems naturalists. Next, I develop a systems naturalists-based, SES problem solving-based, and sustainability-based course as a capstone class for undergraduate coursework, or as introductory coursework for a graduate program. Finally, in "Chapter 12: Toward a More Transformational Sustainability Discourse," I offer some concluding thoughts on sustainability discourse, and discuss the naturalist framework within the context of transdisciplinarity as a synthesis of epistemologies, as well as taking note some of the implications of naturalist principles for sustainability discourse today. Using the principles elicited from naturalists as described here, I speculate about a more transformational vision for sustainability discourse.

CHAPTER 2: THE IMPORT OF SYSTEMS NATURALISTS

In the introductory chapter I defined sustainability, SES-problems, and systems naturalists' holistic thinking. I explored sustainability's historical context and the contributing influences to its conceptual growth. Springing from its modest foundations in the environmental movement and forestry (the area of many early conservationists' focus), the term sustainability is now universal. It has become "the keystone of global dialogue about the human future" (Orr, 2008, p. 1457). In this chapter I further explore the four systems naturalists from the American environmental tradition, give a brief overview of the methodology employed, and touch on some of the implications for sustainability discourse before delving into the six systems naturalists' principles and findings of this dissertation.

The thesis of this dissertation is that the principles of systems naturalists can clarify, enhance, and advance the contemporary and received framework of sustainability discourse that has been inspired mostly by United Nations documents (that I will describe in detail in Chapter 3). A proposition is that current sustainability thinking in the US does not capture the spectrum of essential values and knowledge exhibited by the tradition of American naturalists and ecologists. These deficiencies, I suggest, can be addressed and counterbalanced by an explicit turn toward the tradition of naturalism and more ecological and holistic—or systems-based—thinking.

When beginning this work, I considered many environmentalist, naturalist, and activist writers who exhibited holistic and coupled-system thinking. These included Thomas Jefferson, Johann Wolfgang von Goethe, Alexander Humbolt, George Perkins Marsh, Charles Darwin, John Muir, John Burroughs, P.D. Ouspensky, Michel Foucault,

Donald Worster, Barry Commoner, Jane Jacobs, and Vandana Shiva⁸—all of whom are influential and whose contributions are further discussed in this dissertation to support the systems naturalists’ findings. Some of their influence on the four naturalists of this dissertation, and their ideas on holism, are included here. Many of them, however, although satisfying the bridging of the sciences and humanities, had not written as extensively on economics—an integral part of sustainability thinking—as the selected four naturalists.

Four Systems Naturalists

Four naturalists from four different eras of the American environmental tradition (Thoreau, Leopold, Carson, and Wilson) epitomize naturalists’ ability to relate their findings in seemingly unrelated fields to the whole of knowledge and demonstrate significant holistic qualities. A range of texts first drew my interest to these authors. These included Thoreau’s (1854) lengthy essay on “Economics” in *Walden: or Life in the Woods* (1854); and Ben Minteer’s (2006) and Bryan Norton’s (2005) treatment of Leopold as a pluralistic and transdisciplinary thinker, I was also motivated by the contrast between Carson’s early writings on the sea, and *Silent Spring* (1962), which was clearly a departure from her placid depictions of coastal ecosystems and their multifarious interactions, to a more pointed critique on industry and the application of science. Finally, Wilson’s (1986; 1992; 1998; 2012) writing on the coevolution of genetic (natural) and cultural processes, biophilia, and the unity of all knowledge, as well as his commentary on the other systems naturalists, formed the foundation of this study.

⁸ With respect to my question of “Are there important ideas from other naturalists not covered by these four?” sustainability scholars suggested Lester Brown, Amory Lovins, and Bill McKibben (Redman, p.c. 2014); Vandana Shiva (Santone, personal communication, 2014); David Edinburgh, otherwise mostly “endemic” and “national” naturalists (Bill, Herzog, personal communication, 2014); and Scott Russell Sanders, Mary Austin, Tom Horton, Edward Abbey, John Burroughs—who “like Thoreau, . . . primarily investigated their own home” (Rudy, personal communication, 2014). Note that these authors are found predominantly from the humanities side of the sustainability discourse.

I investigated a considerable amount of each author's writing, making their work the main of unit of analysis. I focused on their most mature works (i.e., *Walden*, *A Sand County Almanac*, *Silent Spring*, and *Consilience*). I justify this in that each author devoted a concerted amount of time to search for connections between environmental and social systems, as well as accounting for the trajectory their views took as they reached a higher level of holistic and SES thought. Each book represents the thinker's most developed, tried and tested thinking on local-to-global sustainability.

Thoreau had written many essays and books, as well as given many lectures at the Concord Lyceum,⁹ including "Economy," and he had been writing in his journal that was over 2,000 pages before producing *Walden* (1854). Leopold's second book after *Game Management* (1933), a much more practical manual about the management of biological diversity, was written after countless articles on forestry, wildlife management, and what today we would call socio-ecological relationships. But Leopold had a lifetime of working in forestry, on town councils, publishing in local newspapers, and working in the university, before he could fully record his mature thoughts about biological health and integrity in *A Sand County Almanac* (1949). Likewise, Carson had published dozens of articles and received high praise for those and three previous books. With *Silent Spring* (1962), she took a much more serious turn as an early environmental activist concerned with the destruction of many of her former research sites through the applications of pesticides (specifically, DDT). Finally, Wilson—who could be counted as a historical naturalist for the importance of his work in the 1960s and 1970s alone— has made a number of bold attempts to unite natural, social, and human systems. It's work that has

⁹ Thoreau devoted much of his life to the Concord "Lyceum," based on Aristotle's concept of a town hall-type lecture open to the public, and delivered by local professionals to share with the community (Mumford, 1961).

blazed a trail for today's sustainability thinkers, and that has engaged some of our largest SES problems in the *Future of Life* (2002).

Many of these systems naturalists' principles overlapped. Moreover, further research showed that they were, in fact, sustainability and coupled-system thinkers who discussed many of the same systematic failures to curb our far-reaching industry, government, and economic system—writers I have come to believe hold the key to transforming our social, environmental, and economic systems. This allowed me to think of them as providing a more useful alternative to the *Brundtland Report* (1987) and other UN frameworks.

These four systems naturalists were all educators who fostered environmental education regarding diverse subjects such as forest management; the relationship between God, nature, and humankind; environmental stewardship; the moral obligations to the natural world; and humility toward natural things that we do not fully understand. Each has made substantial contributions to natural history and/or the science of ecology. Each in their youth was an amateur naturalist and ornithologist, and later in life an activist. Each was an education reformer either in theory, practice, or both, often stressing the importance of education that extended far outside the university. Finally, each presented a fully matured perspective of how nature should and must be treated from an individual point-of-view and as a matter of self-actualization, promoting local-to-global conservation.

System naturalists consistently frame the natural world in terms of both its—and humankind's—health and wellbeing. The beauty of their prose, poetry, and natural storytelling abilities has sometimes obscured their epistemological contributions, which this section will summarize. But the intellectual beauty of nature must also be transmitted to readers through metaphor (Buell, 2005). “[T]he metaphor is everything” in the creative

arts, and can often help forward a discussion of what we don't fully understand such as in SES problem-solving and transdisciplinary thinking (Wilson, 1998; Wilson, 2014, p. 41). Next, I will take a cursory look at each systems naturalist as poet, philosopher, and life scientist.

Thoreau: Transcending Nature/Society Divisions

I begin with Henry David Thoreau (1817-1862) in an era that the naturalist Wilson (1998), the history of science scholar Richard Yeo (2003), and environmental historian Laura Walls (1995) refer to as a unique time in history when the three scientific branches (i.e., sciences, social sciences, and humanities) were considered one interconnected body of knowledge. As Walls (1995) puts it, Thoreau consolidated two competing narratives of holism during his era, one philosophical and one empirical:

[T]he effort to read nature as a 'whole' was shared by many of Thoreau's contemporaries: Goethe, Coleridge, Emerson, Carlyle, Ruskin, Shelling, Paley, Whewell, Humbolt, Darwin Thoreau saw his task to be joining poetry, philosophy, and science into a harmonized whole that emerged from the interconnected details of particular natural facts. (p. 4)

Thoreau's contributions to sustainability come not solely from his ideas about ethics or spirituality, but from his impressive ability to integrate an often unwieldy and disparate spectrum of thought and values (Walls, 1995). Using this insight, he provides insights on capitalism, democracy, individualism, and ecology, ably using them for a wide range of practical applications. His transcendentalism is a legacy that has greatly influenced many, including the other three thinkers of this dissertation (Radkau, 2008). His broader worldview continues to challenge sustainability thinking.

Many sustainability scholars have suggested that naturalists could add valuable environmental and social insights to sustainability thinking. By all accounts, however,

naturalists do not appear to influence the contemporary sustainability discourse, which is predominantly economic in character. Redman and ecologist Amber Bill (personal communications, 2014) agreed that naturalists were most important in sustainability circles for their contributions in helping link biological, sociological, and cultural aspects, but that they were not as useful for understanding the economic dimensions and challenges of sustainability. In this dissertation, I examine Thoreau's contributions to the sustainability paradigm and sustainability practices through his early understanding of what we would today call coupled systems. I also consider his use of inductive reasoning, and the ethical imperative of moderation within his broader social and environmental activism. I focus on *Walden: or Life in the Woods*, and later articles where his thoughts on people, nature, and general conditions of life—especially economics—are inextricably intertwined.

Leopold: Linking Theory and Practice

The next thinker whose proto-sustainability ideas I explore began writing and studying during the turn of the twentieth century. Of the four figures examined, Aldo Leopold (1887-1948), an ecologist, conservationist, forester, land manager, and amateur philosopher, is probably the easiest to link to sustainability discourse (Meine, 1988). He developed a comprehensive “land ethic” that advanced both the fields of environmental ethics and ecology. His extensive work in graduate school at the Gifford Pinchot-influenced Yale School of Forestry, his leadership in the U.S. Forest Service (USFS) and other conservation efforts across the Midwest and Southwest, and his experiences as a professor of Game Management at the University of Wisconsin led him to propose expanded roles for both individuals and governments in environmental preservation, conservation, and restoration (Minteer, 2006; Norton, 2005). His work poses a direct challenge to narrow resource management agendas by introducing broader ethical,

aesthetic, and ecological criteria for determining “good” land use and, by extension, social-ecological sustainability (Meine, 1988). Leopold’s value to sustainability thought, practice, and education stemmed from his transdisciplinary worldview formed through a lifetime of work across academic and management environments (Norton, 2005). His principles serve as a model for examining real-life SES problems and for linking sustainability theory to practice (Norton, 2005). Minter (2006) and Norton (2005) have also elucidated how Leopold’s pluralistic and transdisciplinary worldview presents a pragmatic approach, one that evades polarized ideological thinking that present preservationist vs. conservationist or environmentalist vs. economist dichotomies.

In this dissertation, I place Leopold within a more preservationist and restorationist tradition, and as a representative of the view according moral status to ecosystems. Leopold also spent a lifetime fighting the intense ideological frictions among disparate interest groups like hunters, land managers, conservationists, and farmers. His holistic worldview simply and eloquently works to solve ideological conflicts that prevent important environmental practices from being part of society and that work to integrate natural and social values. Here, I also focus on *Sand County Almanac* (1949), and later articles that discuss stewardship, the preservation of places, adaptive and integrative knowledge systems, and his description of what we would today call an “earth ethic” (Norton, personal communication, 2014).

Carson: Human Ecology and Ecology of the Human

My third systems naturalist is biologist, writer, and environmental activist Rachel Carson (1907-1964). Her 1962 book, *Silent Spring*, brought concerns about the pervasiveness of pesticides in daily life into public awareness and discourse and helped catapult the modern U.S. environmental movement. As a scientist who worked for the US Bureau of Fisheries (later the US Fish and Wildlife Service) and Woods Hole Naval

Research Laboratory, Carson was a gifted naturalist and writer who won the National Book Award for her poetic depiction of the interconnectivity of land and sea life in *The Sea Around Us* (1951). I only briefly touch on Carson's first three books (1941; 1951; 1955), particularly *Under the Sea Wind: A Naturalist's Picture of Ocean Life* (1941), as evidence of her authority as a naturalist and holistic thinker, and the presentation of a new ecological vision for holism by focusing on the intricate but fragile web of interactions occurring at the edge of land and sea.

But, it is her fourth and final book *Silent Spring* (1962) that goes much further into socio-economic dimensions to frame global and multi-generational environmental problems and risks. Carson thus offers an integrated SES-based critique of our relationship with nature. As Carson herself writes, “[t]he history of life on earth has been a history between living things and their surroundings” (1962, p. 297). Carson's primary contributions to sustainability largely derive from *Silent Spring* and highlight the key systems naturalist principles of integrating intrinsic and instrumental values, internalizing economic externalities, and developing an understanding of human health and wellbeing as intimately tied to ecological health and wellbeing. Carson and Wilson together can especially address the complex and integrated SES problems developing in the second half of twentieth century because of their understanding of contemporary ecological science's nested systems of genetics, communities and ecosystems.

Wilson: The Unity of All Knowledge

Edward O. Wilson (1926-), who builds on Carson's understanding of interconnectivity while centering sustainability in global biological diversity, is the last and only living naturalist whose work I explore. Wilson may be seen to have inherited the tradition of Thoreau, Leopold, and Carson, as a reading of his autobiography, *Naturalist* (2006) attests, as well as many other books that specifically mine their

principles. Furthermore, he has extended this ethic in important ways in a mission to preserve global biodiversity. Analysis of Wilson's work provides a contemporary, scientific, and comprehensive view of natural and social systems together. His life's work in the study of animal and human social behavior culminates in *Consilience: the Unity of All Knowledge* (1998), and *The Future of Life* (2002), which provide a broad platform for arguing that we must revolutionize our economy, preserve biodiversity, and greatly improve our social systems in order to be sustainable.

The systems naturalist Wilson's (1998) quest for a contemporary *consilience* of the sciences, social sciences, and humanities has helped revive the tradition of linking natural and cultural knowledge, economics and ecology, science, and ethics. Wilson's theories can guide transdisciplinarity education. His work highlights the convergence of human and natural values through the transdisciplinary theories of *biophilia*, *biodiversity*, *sociobiology*, *conservation biology*, and genetic and cultural *coevolution*; the need for bio- and socio-diversity for stability and survival; developing a contemporary sustainability theory for economics and transdisciplinarity.

Naturalists in the Humanities

Founding sustainability director at the School of Sustainability at Arizona State University, Charles Redman (personal communication, 2014) remarked the four systems naturalists were "tremendously important" to sustainability education. Other scholars agree: "Naturalists are especially important in agency, as individuals inspire. The naturalists' meta-narrative is so compelling and still relevant—there's still a large public wanting to hear about interconnectedness" (Weiskel, personal communication, 2014). This talk of narratives leads us to consider the contribution of the humanities in sustainability theory and discourse, a role that I believe the system naturalists are uniquely qualified to play.

Literature from the fields of environmental history and the history of science and environmental philosophy has discussed the importance of systems naturalist thinking in addressing SES problems. In this dissertation, I have been especially influenced by the research of naturalist historians such as Donald Worster's *The Economy of Nature* (1977), Paul Farber's *Finding Order in Nature: the Naturalist Tradition from Linnaeus to E. O. Wilson* (2000), and Sharon Kingsland's *The Evolution of American Ecology, 1890-2000* (2005) to link the simultaneous expansion in the understanding of ecology and sustainability with American expansionist theory that inherently seeks to dominate and exploit nature. Two very recent books by Enlightenment-to-Modern era historians *Sustainability: A History* by Jeremy Caradonna (2014), and Ulrich Grober's *Sustainability: A Cultural History* (2012) also reinforced the importance of the history of the concept sustainability. Both helped to confirm much of my earlier research of regarding the need to link historical and contemporary sustainability discourse with ecological thought.

I also often refer to work in environmental philosophy ethics, especially that by Bryan Norton (1990; 2005) and Ben Minteer (2006; 2011). Norton's comprehensive volume, *Sustainability: a Philosophy of Adaptive Ecosystem Management* (2005) presents one of the most developed links between Aldo Leopold's life and work and sustainability discourse, including how to coordinate theory and practice. Minteer's *Landscape of Reform* (2006) and *Refounding Environmental Ethics* (2011) explore the social and democratic vision of many naturalists, and introduce Leopold as providing a "third way" that consolidates historical ideological polarizations among environmental views in real-world practices. In doing so, Leopold and his tradition helps construct a framework of representative and pluralistic values in environmental decision-making (Minteer, 2006, pp. 153-87; 2007, pp. 24-5). These three works are invaluable to this

dissertation, providing a link between the four researched authors to sustainability issues.

Minteer (2011) argues that environmental ethicists have mined the American environmental tradition ontologically; but “a candid appraisal of environmental ethics based solely on its public policy and management impact would likely conclude that it was something of a failure” (Minteer, 2011, p. 1). Leopold scholar and ecologist Curt Meine (2014) and other sustainability scholars I interviewed concur: environmental ethics is thought to be an essential part of naturalists and sustainability theory, yet it’s a contribution that has yet to be delineated in any practical or policy relevant sense. “Ethicists haven’t said much about sustainability” (Meine, personal communication, 2014), despite sustainability discourse being replete with inter- and intra-generational ethical decisions central to the *Brundtland Report*. The lack of engagement by environmental ethicists in real-world sustainability problems, however, likely has more to do with environmental ethicists’ philosophical and intensely disciplinary methods, than a referendum on the relevance of early environmentalists and naturalists (Minteer, 2011).

As Wilson (2015) argues in the *Meaning of Human Existence* (2015), the mission to understand humanity’s place in relationship with nature can only be achieved through uniting the science and the humanities:

To understand cultural evolution from the outside looking in, as opposed to the inside looking out, the way we do it, requires interpreting all of the intricate feelings and constructions of the human mind. It requires intimate contact with people and knowledge of countless personal histories. It describes the way a thought is translated into symbol or artifact. All this the humanities do. They are the natural history of culture, and our most private and precious heritage. (p. 57)

Driving Questions and Methodology Overview

Once again, the driving question of this dissertation is *how can the principles of foundational naturalists help clarify, enhance, and advance sustainability discourse?* I explore this overarching question through three interlinked sub-questions:

- i.) How can a re-examination of traditional naturalists' thinking expand and improve sustainability's *paradigm*, or theoretical framework, to better capture a fuller range of human and natural values?
- ii.) How does the holism of systems naturalists, particularly regarding the need to respect scientific and ecological limits within an integrated ecological and economic worldview, inform their work; and why is this perspective critical today to rethinking the contribution of historical naturalists to sustainability *practices*?
- iii.) How can we programmatically operationalize naturalist thinking in sustainability *pedagogy* to make it more integrative, transformative, and ecologically based?

The primary mechanism I employed was a cross-text analysis in the areas of ecology, sociology, literary studies, sustainability, climate change, rising consumption rates, and global SES problems, supported by interviews with sustainability scholars about the content and value of naturalist principles. When conducting qualitative text analyses, a researcher must often make an “educated guess” about the meaning of a specific text. They consider both the author's intentions and the most likely interpretations (Bainbridge, 2014). While the analysis and interpretation of the four naturalists' literature and authorities on their writing is the primary source of inquiry, I also thought it would add value to explore each of the four systems naturalists from diverse disciplinary perspectives and from the various lenses provided by the interviewees.

For this dissertation, working with the primary texts of the four naturalists and secondary texts by other authors that highlighted the naturalists' political, economic, and scientific perspectives, I sought to examine the relationship between the naturalists and current ideas about sustainability thinking and SES problem solving as presented by contemporary sustainability scholars. I applied my findings to design interview questions with many of the sustainability scholars I refer to throughout the book, which, in turn, reinforced findings in the literature review. For a full accounting of methods and responses to interview questions, see Appendix A.

Literature Review

Data collection began with a thorough literature review. The primary units of analysis were the authors' overall meta-narrative found among their writings, and especially in their later and key "manifesto" books (e.g., *Walden: or Life in the Woods* (1854), *A Sand County Almanac* (1949), *Silent Spring* (1962), *Consilience* (1998), and *The Future of Life* (2002), which respectively represent the culmination of each author's work. For this work, "embedded units of analysis" (Yin, 2013, p. 132) are deep sustainability theory, the theory of sustainability practices, and sustainability educational theory —areas that had enough flexibility to apply to traditional naturalists and sustainability scholars alike.

All told, three distinct bodies of literature were used to provide a literature review of naturalist and sustainability theory throughout the dissertation. These are:

1. primary and secondary literature relevant to the four systems naturalists
2. environmental and sustainability (and proto-ecological and sustainability) historiography; and
3. current environmental and sustainability literature.

As noted earlier, many different disciplines and fields represented by this transdisciplinary set of literatures (i.e., environmental history, history of science, sustainability science, biography, etc.) were evaluated in order to describe the relevance of a principle to sustainability thinking. Reading the core works and criticism of naturalists in general led me to a preliminary theory that naturalists were sustainability and systems thinkers prior to the articulation and formalization of sustainable development and sustainability, whose ideas and terminology that appeared later in the post-World War II era as SES-problems became undeniable.

Interviews

The sustainability scholars interviewed were identified in part because their work reflected an understanding of both sustainability and most of the four systems naturalists. All interviewees were familiar with at least three of the naturalists and their writings, perspectives, and values. Analysis of the primary documents together with the interviews with these sustainability “thought leaders” helped reveal shortcomings in current sustainability thinking. Interviewees included:

- Timothy Beatley, Professor of Sustainable Communities, University of Virginia;
- Amber Bill, Manager Community Engagement & Reserves, Parks and Gardens Wellington, New Zealand;
- Peter Brastow, Senior Biodiversity Coordinator, City of San Francisco;
- Edward Cook, Associate Professor, the Design School, Arizona State University;
- Cecelia Herzog, President of Green Infrastructure and Urban Ecology Institute, São Paulo, Brazil;
- Stephen Kellert, Tweedy Ordway Scholar, Social Ecology, Yale University;

- Julie Klein, Professor of Humanities, English, Interdisciplinary Studies and Faculty Fellow, Office for Teaching and Learning, Wayne State University ;
- Dr. Gary D. Lynne, Professor of Ecological Economics, University of Nebraska;
- William “Bill” McKibben, Environmentalist, Author, and Journalist;
- Curt Meine, Senior Fellow and ecologist, The Aldo Leopold Foundation;
- Bryan Norton, Environmental Philosopher, Georgia Tech University;;
- Michael Popejoy, Fellow in the Department of Philosophy, Harvard University;
- Dr. Charles Redman, Founding Director, School of Sustainability, Arizona State University;
- William Rudy, MA and MS of Ecology, Director of Campus Sustainability, Brigham Young University;
- Susan Santone, Executive Director, Creative Change Educational Solutions; and
- Timothy C. Weiskel, Cultural Anthropologist, Cambridge Climate Research Associates, Harvard University.

My interviews with sixteen sustainability scholars were primarily directed toward determining how to augment sustainability education positively. In addition, they explored naturalists’ contributions to theoretical and epistemological contributions versus UN-based thinking to support the overall methodology of the literature review and sustainability classroom work. The results of these interviews established that sustainability scholars would like to see naturalist theory, practice, and education inform and enhance sustainability thinking.

At the end of the interview process, the questions and results were organized according to three broad and overlapping embedded units of analysis: (a) deep sustainability theory, (b) the theory of sustainability practices, and (c) sustainability educational theory. Answers provided qualitative data only, which was used to informally “test” the hypothesis that the principles of traditional American naturalists can enhance the current sustainability framework as applied in a university education setting by returning it to long-tested values of coupled socio-ecological systems (SES) and a more transdisciplinary approach common to naturalists.

I used interviews to (1) continually guide and test an evolving set of principles derived from naturalists; (2) guide my thinking about system naturalists’ proto-sustainability thought in the areas of sustainability theory, practice, and education; and (3) to draw cross-case conclusions (and determine external validity). The results summarized in Chapter 13 and in Appendix A. helped motivate an in-depth study of naturalists. As answers concurred with, or presented debate over, many of the ideas and assumptions of this dissertation, they merited further investigation. Answers also helped shape the direction of the project. For instance, interview results supported the belief that many components of the existing economic system were inherently flawed, and naturalists were apt to point that out.

Many of the interviewees’ suggestions were included in the implications to sustainability discourse for this project and seemed representative of issues often discussed informally, but not in the classroom. Academic discussion is often geared to what can be accomplished in a few years, or even a semester, and as Norton (personal communication, 2014) commented, it has “lacked an ongoing procedural framework that would capture plurality,” or for the focus of achieving long-term goals. As interviews suggest (see Appendix A), naturalists have already developed a corpus of highly useful

principles at the intersection of our cultural and natural histories. These enormous fields of inquiry have long had an abstract and dialectical correlation. Furthermore, sustainability scholars contend naturalists can ably help to bridge the sciences and the humanities in a way that is more comprehensive and clear than what comprises the current sustainability discourse.

Implications for Sustainability Discourse

A complete and holistic framework is essential for the teaching of sustainability (Pijawka, Yabes, Frederick & White, 2013, p. 24; Steiner & Posh, 2006; Thomas, 2009). Yet, a review of historical and current sustainability literature, prominent sustainability criticism, and sustainability education literature, and interviews with sustainability scholars reveals that many holistic naturalist principles are wholly absent from current sustainability discourse and education. Systems naturalists have resisted academic compartmentalization and succeeded in integrating a wide range of competing viewpoints and values. Therefore, their work has significant implications for sustainability discourse.

As environmental activist Annie Leonard (2011) argues today, “Everything exists as part of a larger system and must be understood in relation to other parts” (p. xv). This dissertation can help clarify, enhance, and advance sustainability paradigm, practices, and pedagogy by demonstrating the seriousness of environmental limits; the historical, integrative and transdisciplinary spectrum of values that grounds and thus must be a part of sustainability debates and discourse; and the consequences of exceeding carrying capacity. This naturalist framework provides a mechanism for transforming today’s narrow, utilitarian framings of sustainability. Such constrained approaches fails to reflect the true complexity and magnitude of SES-problems in sustainability theory, practices, and pedagogy.

A Paradigm of One Coupled System

The long view provided by our cultural and natural histories may be our greatest asset. Naturalists’ views on ethics, economics, education, democracy, and environmental limits, and a score of other inter-related topics, can enhance deep sustainability theory through the merging of our cultural and environmental histories, and the subsequent recognition of the convergence of human and natural values in the twenty-first century. Literature review and interview results reveal opposing ideological stances as detrimental to sustainability. The assumptions of Killingsworth and Palmer’s (1995) ecological and environmental rhetoric model guide my framing of the problem and proposed sustainability education solution (Figure A).

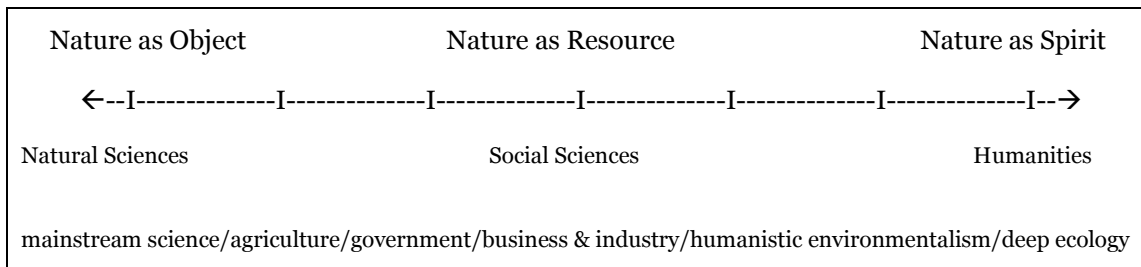


Figure A. Perspectives on Nature. Nature is generally viewed in anthropocentric and non-anthropocentric ways by different fields (Killingsworth & Palmer, 1995, p. 8).

Systems naturalists view nature across all three perspectives—“Nature” as: “object,” “resource,” and “spirit” (Killingsworth & Palmer)—due to their holistic approach and also through the use of creative thought and *inductive reasoning*, or “reasoning in which the facts summed up in the conclusion are not among those stated in the premises” (Pierce & Moore, 1998, p. 297). This enables them to consolidate premises and principles of disparate fields of inquiry (Walls, 1995; Wilson, 1998). Wilson (1998) has called this aspect of the traditional naturalists, and the historical aspiration to unite

all the “great branches of learning” (known today as the natural sciences, social sciences, and humanities, or “three branches”), the “Ionian Enchantment” (p. 8).

In other words, systems naturalists have the scientific training and perspective to view nature as a whole. Further, they possess the depth to apply philosophical, historical, and ethical principles to what we would today call sustainability problems by bridging the “two cultures” of science and literature (Snow, 1959). While systems naturalists are ground-breaking in their ecological research, they are also firmly rooted in history, religion, philosophy, and especially ethics. “Moral knowledge came to be part of their naturalistic thinking . . . naturalism as a philosophy deserves a more prominent place in considerations of land ethics” (Knight & Reidel, 2002).

This aspiration to achieve the unity of all knowledge, however, began to dwindle somewhere during the second half of the nineteenth century, as the post-Darwin era saw both the sciences and humanities become increasingly bifurcated, fragmented, and specialized (Walls, 1995; Wilson, 1998). As Newton and Freyfogle (2006) point out, the “special challenges of ecology” demand humility toward nature. Based on my analysis of systems naturalist principles, the four argue for a sustainability discourse that is rooted in:

- The Integration of Natural and Human Systems (Principle #1); and
- A Paradigm of Interdependency (Principle #2).

Reviving historical naturalist theory could help ameliorate the polarizations and untenable compromises between conservation and development. It also has the potential to clarify the inherent complexity of sustainability and SES problem solving. A naturalist framework, for instance, could contribute to sustainability discourse by revealing that long-term sustainability must be guided by the *precautionary principle*, highlighted in

the Rio Declaration, which placed the burden of proof that pollutants are not harmful on the producers of pollution instead of the public (UNEP, 1992). This concept is currently taboo in American politics (Bodansky, 2014; Hoggan, Littlemore & Bell, 2009).

Sustainability, however, must be precautionary. It must respect the unpredictability and complexity of ecosystems in a world we have yet to fully understand. Finally, a naturalist's worldview—especially since Rachel Carson—takes place on many levels that are multi-scalar (including local to global), a mandate of long-term sustainability.

Framing Economic Practices around Ecological Limits

Until sustainability places more importance on the limits of our life-support systems; comprehensive environmental ethics; a human economy embedded in the natural economy; and obligations for both government and citizens, we will fail to achieve real sustainability. Ecological economists (Lynne, personal communication, 2014) argue to replace the neoclassical economic framework and policies that promote perverse subsidies and encourage the substitution of wealth for ecosystem resources with one that preserves natural capital, ecological health, and a sense of place simultaneously by linking our ecological and economic systems in ways that incorporate current market externalities (Costanza, 1997; Daly & Farley, 2004).

Thus, I posit that further examination of this historical work can enhance its modern application to sustainability practices by:

- Absorbing Environmental Externalities (Principle #3); and
- Economic Practices within Ecological Limits (Principle #4).

Contemporary ecologists Brian Walker and David Salt (2006) have collaborated with the ecologist C. S. Holling (2001) to propose a framework of resiliency thinking, one that uses SES as the basis for sustainability practices. Resiliency thinking operationalizes sustainability by placing emphasis on precaution in the face of uncertainties rather than

efficiency (Walker & Salt, 2006). However, few urban plans incorporate resiliency principles or acknowledge the vast ecological footprints that extend far beyond municipal boundaries and national borders (Pijawka, 2015). The germ of resiliency thinking, I believe, can be found in naturalist writings.

Uniting the Three Branches for Sustainability Educational Theory

Sustainability education scholar Ian Thomas (2009) has described Education for Sustainability (Efs) (as differentiated from Education for sustainable development [ESD]), as

- a systemic approach—showing a holistic perspective and accessing inter- and transdisciplinary understanding
- exploration of the effects of decisions and taking action—what pressures will be placed on the biophysical environment and on society, who (human and other species) will be directly affected, and asking what will be the positive and negative effects? and
- decision-making based on ethics—values-based exploration of the issues and options, with decisions being guided by a set of ethics derived from human rights and ecological rights. (p. 249)

Sustainability scholars argue for environmental, ethical, governmental, economic, and educational applications over the long term through the creation of an integrative and conciliatory-based education (Wilson, 1998). Many universities are now overtly seeking to design curricula and form networks—as well as create their own sustainability frameworks—with the mission of achieving interdisciplinarity or transdisciplinarity to solve tough socio-ecological problems (AASHE, 2013; Pijawka, et al., 2013). *Trans*-disciplinarity represents a higher integration than *multi*- or *inter*-disciplinary studies. In short and by example, the former requires the thinker (or

student) to assemble the pieces, like in a traditional liberal arts program, while the latter certainly may be holistic but is based on the coordination of two or more disciplines (Odum & Barrett, 2005).

I posit that the normative and transdisciplinary links provided by the four naturalists explored here can help guide sustainability education through a time when U.S. political systems and governmental decision makers are distinctly polarized and relatively dysfunctional. Naturalist principles can be inserted into any sustainability education curriculum to help foster a more robustly ecological, effective, and complete sustainability framework. And ultimately, naturalist theories can be integrated into the teaching of any type of sustainability-related course. Naturalists' concepts, values, and principles provide a more balanced, nuanced, and realistic view of socio-ecological problems over the long-term by:

- Normative Sustainability Educational Theory (Principle #5); and
- Transdisciplinary Education¹⁰ (Principle #6)

Normative sustainability thinking (Norton, 2005), and transdisciplinarity (Klein, 1990; 2006) promotes the integration of these disciplines by a continual “unlocking of cause and effect explanations across and among disciplines” (Odum & Barrett, 2005, p. 13). In response to the demands of SES problems, Arizona State University (ASU) President Michael Crow (2012) has made it the university’s mission to transform education and produce “a new generation of leaders through collaborative, transdisciplinary and problem oriented training” (p. 1).

To find answers for our future, we need to look to the past. As mentioned above, almost universally across their many disciplines of origin, sustainability theorists have

¹⁰ A *normative* sustainability based platform based on precaution in ecosystem management, environmental preservation, and human equity, as opposed to a weak sustainability model that preserves economic wealth only (Norton, 2005).

neglected our natural history. Our cultural history reveals theoretical and ethical paradigms that have not properly recognized the fragility and importance of ecosystem health and integrity; or they assume environmental ethics as something wholly separate from social and religious duties. In other words, in most of Western culture, one has historically been able to fulfill moral duties to oneself, and ethical values to society, while concomitantly advancing in ways ultimately harmful to local, national, and global environments. This comes into play in ethical frameworks that for historical reasons have neither not included human duties and obligations to the natural environment, thus contributing globally to a modern-day “tragedy of the commons” (Hardin, 1969).

CHAPTER 3: WHAT IS SUSTAINABILITY? THE RECEIVED TRADITION

Where did the concept of sustainability truly originate, and what should sustainability principles encompass? When discussing the origins of sustainability, most people refer to the three pillars derived from the United Nation’s (UN) *Brundtland Report* (WCED, 1987)—also known as “Our Common Future” (see Figure B). The terminology of the *Brundtland Report* may appear novel; the *Oxford English Dictionary* (*OED*), however, dates the first contemporary usage of ‘sustainable’ to 1953 and 1956—over three decades prior—as “capable of being maintained at a certain level,” while business articles referred to it when talking about “resource development” and “economic growth.”

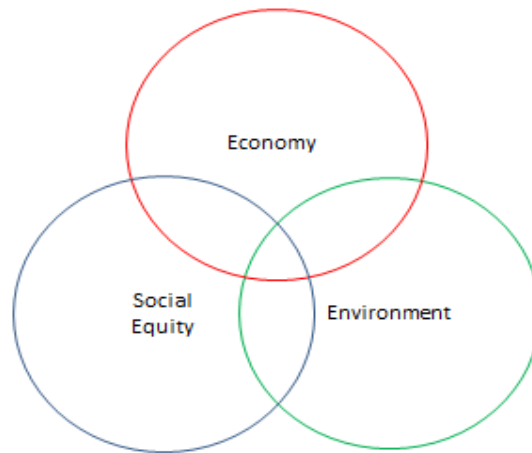


Figure B. The Three Pillars. These were introduced with the 1987 *Brundtland Report* and widely accepted by the 1992 *Earth Summit*.

Defined simply as the *capacity to endure*, sustainability has been a significant societal concern for as far back as we are aware (Grober, 2012).¹¹ Sustainability discussions have guided societies whenever signs of dwindling resources and collapse make themselves apparent. As Jared Diamond writes in his influential 2006 book, *Collapse: How Societies Choose to Succeed or Fail*, “problems of toxic wastes, forests, soil, water (and sometimes air), climate changes, biodiversity losses, and introduced pests” are among “the dozen types of problems that have undermined pre-industrial societies in the past” (p. 35). Moreover, anthropologists and geographers like Diamond have demonstrated not only how these SES problems reduce the area’s carrying capacity, but also how they were a major concern for past societies, if not their driving force. Therefore, we can go back much farther than the *Brundtland Report* (1987) in our search for the fundamentals of sustainability.

While the three pillars embrace some of the same general themes as systems naturalists, I suggest that the UN-based framework does not capture the full spectrum of ideas expressed by the systems naturalist tradition. I devote this section to what I posit

¹¹ Examples of collapse into a dark age include the Sumerian city-state of Uruk (c. 4000 B.C.) whose population densities were roughly equivalent to those experienced by modern Parisians—the highest in the Western world (Boone & Modarres, 2006). Linden (2007) attributes the demise of Uruk to a 200-year drought between c. 2200-2000 B.C. that led to a 93 percent decrease in population. Brown (2011) instead attributes ecological and social demise to salt concentrations in the soil and “an environmental flaw in the design of their otherwise extraordinary irrigation system” (p. 9)—a source of many failed states that still exists today. But, whatever the cause, ecological events extinguished the Sumerian economy, then its society, snuffing out even the language itself (Konfirst, 2012).

Environmental and socio-economic issues conspired to collapse civilizations, even in the ancient world. In the Minoan civilization (2600-1400 B.C.) on the Greek island of Crete, for example, the devaluation and under-valuation of crops led first to population exceeding capacity, then famine, then the absorption of their culture into a larger and more powerful city-state, and as such was the fate of Athens. Agricultural terracing of the Greeks demanded significant amounts of physical labor, in what McNeill (200) calls a “somatic energy regime” (p. 11). When invading forces removed this energy source (e.g., slaves), Athens and other Greek city-states no longer had the energy to keep their farms from eroding into the Aegean (McNeill, 2000). The systems naturalist George Perkins Marsh (1864) delivered a strong polemic against deforestation based on the collapse of Mediterranean civilizations from desertification, in *Man and Nature: or, Physical Geography as Modified by Human Action*.

are the pivotal intellectual changes that precipitated the *received framework* of contemporary sustainability.

In this chapter, I discuss influential thinkers and UN documents that have shaped (and, from my perspective, limited) today's "received" sustainability paradigm. The received framework is centered on the production and growth of wealth promoted explicitly and implicitly by iconic historical sustainability figures who were also economists: Carl von Carlowitz and Gifford Pinchot, two icons of sustainable forest production. Perpetual economic growth schemes are implicit as well as within UN Literature (especially *Brundtland*). It also values nature primarily as a resource to be used in this production and growth and not for its intrinsic value as *the* system that sustains life on Earth.

In ecology, *sustainability* refers to "a state that can be maintained over an indefinite period of time" (Du Pisani, 2006, p. 91). Yet legal arguments, land management, public vs. private interests, and other contemporary applications that have often been based on short-term benefits to human society have dominated much of human activity.

Historical Thinkers of the Received Tradition

This section will begin by describing the contributions of a European accountant and forest master, as well as an American forester and conservationist, who have most influenced the intellectual understanding of the concept of "sustainable yield." Sustainable yield, "the maximum level at which a natural resource can be routinely exploited without long-term depletion" (Oxford, 2014), spread from Europe to America through the science of forestry (Callicott & Freyfogle, 1999). Although the contemporary sustainability discourse may begin with the 1972 United Nations Conference on the Human Environment (many members of which later penned the *Brundtland Report*),

the concept of sustainability has very clear roots in Enlightenment (1600-1800) and scientific forestry practices geared at conserving this vital resource and increasing national wealth (Caradonna, 2014; Grober, 2012).

Dwindling timber supplies following the Thirty Years War (1614-1648) in France and Germany, and the seeds of modern industrialism, were inextricably integrated with the management of forests, the source of the contemporary sustainability concept (Caradonna, 2014). In this climate, von Carlowitz, whom Grober (2012) and Caradonna (2014) consider the “father of sustainability” and European forestry practices, promoted the concept of sustainable yield. This European economic-based sustainability tradition in the management of environmental resources would also directly influence Gifford Pinchot, who brought scientific forestry to America (Grober, 2012).

Sustainability and the Birth of Industrialism

Hans Carl von Carlowitz (1645-1714) managed the planting and cutting of conifers to fuel the mining industry when the degraded state of the forests in Germany started to present economic and expansion problems for the state (Grober, 2012). Naturalist theories and concepts would not be integrated into mathematical forestry practices until the end of the eighteenth century (Romberger & Mikola). Needless to say, these practices did not account for economic externalities of biodiversity and soil loss, and the homogenization of most of Germany’s forests into spruce and pine stands that have presented a considerable challenge for forest sustainability in the 20th century (Leopold, 1936) and today.

Von Carlowitz learned from what was then the wealthiest and premier forest managers under France’s King Louis XIV (1638-1715). Jean-Baptiste Colbert (1619-1683) had begun managing forests primarily to support Louis’ shipbuilding for global trade and war (Grober, 2012). After touring Colbert’s managed forests in 1713, von Carlowitz

introduced the concept of “sustained yield forestry” to Germany (Caradonna, 2014, p. 7), implementing many of Colbert’s advanced practices. He published *Sylvicultura oeconomica, oder haußwirthliche Nachricht und Naturmäßige Anweisung zur wilden Baum-Zucht* (loosely translated as *Forestry Economics’ Nature Decree: Moderate Instructions for Wild Tree Breeding*) in 1732. This comprehensive treatise tied the endurance of the mining industry directly to the development of German forestry (DuPisani, 2006), and was the first book in mathematical precision to account for how forests, shipbuilding, and iron smelters enabled exploration and colonization.

By the seventeenth-century, Germany had greatly accelerated the destruction of its forests nearly stripping them clean for building its navy, and to access the copper and iron ore needed for smelting during the seeds of European industrialism (Grober, 2012). As the environmental realities of a small country with limited resources that constricted the growth and development of the population, von Carlowitz recognized that Germany could not be economically and instrumentally sustainable, founding and framing the concept of sustainability in capitalist and expansionist terms.

Von Carlowitz employed economics as the dominant metaphor and wrote primarily to keep both the copper and iron mines and the German colonial apparatus running (Grober, 2012). In this writing, von Carlowitz coined the term *nachhaltigkeit* or “lastingness,” the contemporary German word for “sustainability” and a definition very close to our own (Du Pisani, 2006, p. 85). *Nachhaltigkeit* described forests that remain eternally productive and autonomously regenerative, while still producing enough harvest to profit economically (Du Pisani, 2006). However, spruce and pine that out-yielded other tree species were planted ubiquitously throughout Germany during this era, changing the ecosystems (Grober, 2012; Meine, 1988). During the Enlightenment, the new occupation of “forest managers” employed von Carlowitz’s sustainability concept

in increasingly strict regulatory measures that geared forests toward the productivity of the nation.

German environmental historian Joachim Radkau (2008) argues nevertheless that Germans embraced sustainability long before von Carlowitz. “That ‘the Limits to Growth’ was self-evident to them most of the time . . . every peasant had to practice a more or less sustainable husbandry to ensure his survival” (p. xvi). Von Carlowitz, however, defined sustainability primarily as *economic sustainability* for the sake of national industrialism and economic growth, a worldview that still dominates much of today’s sustainability discourse. This worldview was propagated further by Gifford Pinchot, who was a major force in shaping the idea of conservation in the late nineteenth and early twentieth century in America.

Conservation and Sustainability

The first prevalent use of the Greek root *sustene* in America can be traced to Gifford Pinchot (1865-1946), the first Chief of the U.S. Forest Service. Pinchot was the right hand man and advisor of all things conservation to President Roosevelt, himself an amateur naturalist. During his tenure, Pinchot’s department began using the term sustainable yield as a guiding objective in the long-term commercial management of American forests. The objective aimed to ensure largest harvests without degrading long-term productivity. In 1905, he published “The Use of the National Forest Reserves” manual, which was dedicated to applying the neoclassical concept of supply and demand to forest management.

Pinchot’s ideas would guide not only the U.S. Forest Service but also the first forestry school, the Yale School of Forestry, which Pinchot’s family founded in 1900 (Grober, 2012). Pinchot marveled at the efficiency of American industrialism, which made the citizens of the United States the most materially prosperous in the world.

Despite being fired by President Taft for insubordination in 1910, Pinchot's *sustainable yield* legacy in the American dialogue was a longstanding one (Hempel, 2012, p. 396) with broad impacts and pervasive acceptance of the maximum sustainable yield concept (Callicott & Freyfogle, 1999; Merchant, 2007) persisting well into the 1930s (Grober, 2012; Hempel, 2012).

Pinchot received his graduate training in France between 1880-90, studying directly under Sir Dietrich Brandis (1824-1909), a minor but "textbook" utilitarian (Grober, 2012).¹² It was during this time that Pinchot's philosophy formed (Miller, 2009). It was based, in part, on Colbert's *bon usage* (which Pinchot translated as "wise use") and Pinchot traveled to Germany to observe the concept in action (Grober, 2007, p. 25). Like his professor, Pinchot was a devout utilitarian and represented the *conservationist* worldview of the times, one that many later conservationists (including Aldo Leopold) did not consider to be in accordance with good ecological science (Callicott & Freyfogle, 1999). "Pinchot saw conservation in terms remarkably similar to those used by the Brundtland Commission to define sustainable development," Hempel (2012) argues.

While Pinchot did have naturalist sensibilities, basing some of his philosophy on George Perkins Marsh's (1801-1881) *Man and Nature* (1864), he promoted a progressive and economic-growth-based model for ecological management. For this reason, his *anthropocentric*, or human-centered and instrumental, perspective is often contrasted with the naturalist John Muir (1838-1914), who advocated that *preservation* of natural resources be defined in *non-anthropocentric*, or nature-centered, terms and that the

¹² Brandis was a part of the utilitarian philosophy of Jeremy Bentham (1748-1842) and John Stewart Mill (1806-73) that dominated the thinking of this era of English history. Like many thinkers in the 19th century, Brandis placed an economic value on ecosystems preeminently in terms of supporting the maximum possible number of human beings, for maximum happiness (Grober, 2012).

environment be valued intrinsically for its own sake (Minteer, 2006). The controversy that developed around Pinchot's and Muir's philosophies also separated American environmentalists into conservationist/preservationist and anthropocentric/non-anthropocentric camps, with the latter stressing instrumental values, and the former emphasizing the intrinsic values of nature (Norton, 1999). Similar divisive ideological issues among interpreters of sustainability and environmentalism continue to polarize the sustainability discourse today (Du Pisani, 2006; Minteer, 2006; 2007; Wilson, 2002).

Char Miller (2009), a contemporary Pinchot scholar, describes Pinchot as someone who viewed the dwindling resources of the nation as a threat to national security, and a pragmatic manager who sought to conserve American forests in the best way he could. I suggest that Pinchot is best thought of as an early interdisciplinarian outside of the system naturalist vein, who helped unite the fields of resource management and economy and instigated environmental regulation in an era when there was none. He protected the U.S. from the "robber barons," who ironically later co-opted his term "wise use" for their own purposes "in an early form of green-washing" (Grober, 2012, p. 151). His view of making natural resources productive nonetheless has had long-lasting consequences.

It was not until the late twentieth century, however, that the term sustainability began to take on great import. This began to transpire when a much larger scale of the global interconnectedness among governments and commerce—as well as greatly accelerated technological development—emerged. This broader global worldview projected the concept of protecting limited resources for human development onto the world stage and into international discourse, essentially shaping our view of sustainability today.

The Received Sustainability Framework: UN Literature

The 1972 United Nations Conference on the Human Environment (UNCHE) held in Stockholm introduced the term *sustainable* to what would be an ongoing, post-WWII development discourse (UNEP, 1972). This discourse focused on the economic value of resources and increasing Gross National Product (GNP) of developing countries (Robinson, 1993). *The Brundtland Report*, released in 1987 just prior to the end of the Cold War, reinforced the outcomes of UNCHE and promulgated the human- and economic-centered focus of sustainable development.

Environmental historian William Cronon has identified 1987 as the year when sustainability became the center of human development discourse (Cronon, 2011). Since then, discussions such as the 1992 *Earth Summit* of Rio de Janeiro and the World Summits on Sustainable Development (WSSD, 2002; 2012) in Johannesburg have embraced the concept, firmly establishing it as the framework for global discussions (Grober, 2012). I will next examine this process via three key documents that led to the concept of sustainable development becoming the ubiquitous catchall term for environment and development (i.e., sustainability) discourse.

The Stockholm Declaration

Arguably, the contemporary sustainability framework began with the environmental movement.¹³ However, the received sustainability framework explored here likely begins with the UNCHE, the prelude to the *Brundtland Report* (1987), and published the same year as *Limits to Growth*. The resulting *Stockholm Declaration* (1972) considered “the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human

¹³ The beginnings of the “environmental movement” vary, from William Wordsworth and the Romantics, to Emerson and the transcendentalist movement in New England, to Rachel Carson’s *Silent Spring*, to Lois Gibbs protest of the Love Canal and other events in the 1960s.

environment” (UNEP, 1972). This document establishes sustainability’s first real set of economic development principles and is considered by the authors of the *Brundtland Report* to be first in the lineage that led to their report and the three-pillar framework of sustainability thinking.

Despite including the conservation of important natural resources, *Stockholm’s* predominant interest was in the growth of economic markets for the developed and developing worlds. It received attention and praise by subsequent UN bodies, which have reinforced its values and creating a path for later UN documents like the *Brundtland Report* (1987) and the *Earth Summit* (1992). This path clearly emphasized development over environment.

In the first part of the *Stockholm Declaration*, one sees the ideals of protecting the oceans, wildlife, and preserving non-renewable resources. Looking further, however, we begin to see many of the inherent contradictions in trying to advance sustainability in the contemporary world. For instance, Principle 8 states “[e]conomic and social development is essential for ensuring a favorable living and working environment for man and for creating conditions on earth that are necessary for the improvement of the quality of life” (UNEP, 1972, p. 2). This overtly places the two broad fields of inquiry development and environment at odds. Further, it places development (with its unwavering emphasis on the built/managed or human environment) as the central area of inquiry.

Principle 11 goes even further by placing development first, stipulating that environmental policies may not hinder growth:

[T]he environmental policies of all States should enhance and not adversely affect the present or future development potential of developing countries, nor should they hamper the attainment of better living conditions for all, and appropriate

steps should be taken by States and international organizations with a view to reaching agreement on meeting the possible national and international economic consequences resulting from the application of environmental measures. (UNEP, 1972, p. 2)

Traveling further down the list of principles, the terms we encounter most are those framing sustainability with respect to human-centric benefits. For example, Principle 14 states that conflicts “between the needs of development and the need to protect and improve the environment” (what we call tradeoffs today) will be solved by “rational planning” (UNEP, 1972, p. 2). Principle 18 focuses on science and technology and “their contribution to economic and social development,” but without addressing the myriad of unintended consequences caused by its use and overuse. Finally, Principle 21 boldly claims that states have:

the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction” (UNEP, 1972, p. 4).

The last statement fails to consider global interconnectivity or the broadly variant levels of environmental policies among different countries. Remarkably, it even seems to encourage countries to deplete resources.

The Brundtland Report

Our Common Future: Report of the World Commission on Environment and Development, which built on UNCHE principles and is commonly known as the *Brundtland Report* (WCED, 1987), grounded the meaning of sustainable development in its current usage. *Brundtland's* major strength lay in its premise that sustainable development required addressing social inequities through democratic pluralism (Boone

& Modarres, 2006; Minter, 2011; Norton, 2005; Ostrom et al., 1999). It recognized “the changing role of women” and “the right to self-determination” (WCED, 1987: 2.51, 4.6) and provided women with an equitable share of the discussion. Never before had universal social justice been indissolubly linked to issues of conservation as an immediate goal (Mebratu, 2001). But it only recognized ecosystems as instrumental to human needs, as described by this document: “[S]pecies and ecosystems must be preserved because they have an ‘economic value’ that is deemed crucial for development and important to human welfare” (WCED, 1987, 6.5).

Another important premise put forth by the *Brundtland Report* is the most universally accepted concept of intergenerational equity to date defined by the statement—“development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, 1.1). This guiding concept of “future generations” as well as the *Brundtland Report’s* three pillars framework have proven to be instrumental in shaping global and U.S. urban sustainability indicators (Pijawka, 2015).

But while opening up important normative discussions, the *Brundtland Report* only touched on the subject of environmental resources previously absent in discussions about development, and does not address SES problems of carrying capacity (Rees, 1992). According to environmental historian Donald Worster (1993), in the *Wealth of Nature: Environmental History and the Ecological Imagination*, “all that is new in the *Brundtland Report* and other recent documents is that they have extended the idea [sustainable development] to the entire globe” (p. 144). It did not recognize the ecological phenomena that contribute to making a SES-problem, such as positive feedback loops, cascading socio-ecological effects, ecological limits, and thresholds. Nor

did its authors explicitly address the complex web of ethical issues surrounding development (Minteer, 2011; Orr, 2002).

A commission called the World Council on Environment and Development produced the *Brundtland Report* (1987). As the commission's name suggests, the report aimed to establish a compromise between conservation and growth (Du Pisani, 2006). Neither Brundtland nor the three pillars of sustainability that it mentions—environment, society, and economy—were ever intended to be the cornerstone of all future sustainability discussions (WCED, 1987).¹⁴ Even its most transformative initiatives, such as the construction of LEED-certification indicators that number in the hundreds, and the aggregate of many efficiency measures, may become obsolete. Kellert, for example, writes that the existing concept of *sustainable development* is not sufficiently transformative and will at some point become outmoded (Kellert, 1993). This makes the *Brundtland Report* a one-dimensional, development-focused document that lacks the depth and breadth of socio-ecological systems (SES) analysis by scientists, ecologists and system naturalists.

But once the *Brundtland Report* had captured the attention of development and planning theorists and practitioners, “trading-off” among the three pillars became an intrinsic and common reality in sustainability planning (Gibson, 2006). Interestingly, while the *Brundtland Report* refers to many three-term groupings like “environment, energy, and economy,” it only refers to the well-known “three pillars” once. It was the UN-led *Earth Summit* of 1992 that truly established the concept of the three pillars after

¹⁴ For instance, while the *Brundtland Report* makes reference to many 3-term groupings like “environment, energy, and economy” it makes reference to our well-known three pillars only once. The terms “environment and development,” are paired 42 times, and more telling of the relationship.

it gained strength outside of UN documents, which I discuss more in depth in Chapter 4 (Grober, 2012).

The Earth Summit

The UN's Rio Convention of 1992, also known as the *Earth Summit*, was a large, enthusiastic, and optimistic gathering of governments, businesses and non-governmental organizations (NGOs) focusing on environmental and social issues such as combating poverty, deforestation, and the transfer of technology. National leaders from 180 countries attended the conference along with about 30,000 overall attendees. It marked the twentieth anniversary of the *Stockholm Declaration and Limits to Growth* (1972). It took place during the publication year of Meadows' follow-up book, *Beyond the Limits* (1992), which reported that although the world had not collapsed as predicted, the carrying capacity of the Earth had been exceeded.

By the *Earth Summit*, urban development had become the main forum for a sustainability discourse, especially since at the same time William Rees and Mathis Wackernagel (1992) coined the term *ecological footprint*. Earlier that same year, the Canadian ecologist William Rees (1992) came out with a seminal argument using what he called the *environmental footprint*. Rees nevertheless represents but a handful of sustainability scholars who actively answer the foundational ecologist Eugene Odum's (1971) lament that "Great cities are planned and grow without any regard for the fact that they are parasites on the countryside which must somehow supply food, water, air and degrade huge quantities of wastes" (p. 371). Only ecologists like James Lovelock (1979; 2009) and William Rees have been among the few who see first, that unsustainable practices are rooted in a society of domination and exploitation of the environment; and second, that although most people discuss the fact that social and environmental systems

risk breaking down, but there is little trace of a radical agenda for changing the socio-economic systems that foster our unsustainable habits (Hopwood, 2005).

The Earth Summit concentrated on actual environmental problems such as climate change, rising consumption rates, biodiversity loss, new sources of pollution, and the depletion of tropical rainforests and the ozone layer. New approaches for contending with complex SES problems, such as Agenda 21, were introduced. Agenda 21, a non-binding but important pledge, encompassed four areas—social and economic dimensions, conservation of resources in development, the strengthening of minority groups, and probably most important, the means of implementation often lacking in other treaties focused on climate change (Summit, 1992). With Agenda 21, a shift occurred from global ideals and principles to city initiatives, policies, and plans. Municipal Climate Action Plans illustrate this.

The Earth Summit was fraught with problems from the start however. Some saw it as a complete failure given that much of the focus consisted of renewing pledges made twenty years earlier in Stockholm (Grober, 2012). The conference was “anything but a harmonious exchange of views” as the division and frustration of a growing stalemate between what was now being termed the global “North and South” (a.k.a. “developed and developing”) emerged (Grober, 2012, p. 185-6). “Eco-efficiency,” central to the talks in Rio, ultimately requires countries to increase efficiency by an almost impossible factor of ten, to avoid business-as-usual policies (von Weizsäcker, 2014). Furthermore, many of its ideas lost momentum over time, as the *Earth Summit* was not a formal treaty.

Some of these ideals were considered at the Rio+10 Conference in Johannesburg, but they became watered down as discussions were “almost paralyzed by a variety of ideological and economic disputes, by the efforts of those pursuing their narrow national, corporate, or individual interests” (Meadows et al., 2004, p. xiii). In the US,

discussions on this treaty and others have often shut down in Congress, as the bylaws do not require them to review non-binding agreements.

The Received Tradition: Discussion and Conclusion

Foundational sustainability thinkers circumscribed a tradition of forest management to fuel colonization and economic growth. Carl von Carlowitz, an accountant, first coined the noun form of sustainability in the management of forests; and Gifford Pinchot, brought European management principles to America in the form of “sustained yield” and “wise use.” Since the beginnings of American forestry, the United States Forest Service’s (USFS) goal has been to “establish a system of publicly owned forests to be managed by scientific experts” for “providing a sustained yield. (Hirt, 1994, p. xix). The vision that an arbitrarily set value of sustainable yield could incorporate long-term ecosystem trends was overly idealistic. Private interests eventually put a multitude of pressures on this organization in the years to come that drove USFS further from its more “idealistic” roots (Hirt, 1994, p. xix).

This paradigm of making forests efficient and productive set the stage for a natural resources management paradigm presiding in the form of national and industrial economic wealth and growth. When Leopold visited Germany’s forest in the 1930s, he saw the impact of intensive forest management that he thought was “as disastrous for wildlife as it had been for forests” (Meine, 1988, p. 354). In the US in 1944, the “Sustained Yield Management Act” based on precedents set by Pinchot, helped significantly deplete forests by the 1950s, due to governmental faith in government-industry relationships and the employment of German tree-farm practices (Hirt, 1994).

The UN has forwarded a paradigm of scientific management based on economic wealth and perpetual growth. While the UN has produced tens of thousands of pages devoted to sustainable development and solving global SES problems, its approach has

not sufficiently framed the solution and therefore, has not proven entirely effective. For example, the UN's *Brundtland Report* (1987) and the *Earth Summit* (1992) set a framework based on the "three pillars" of environment-economy-social justice and "future generations," which has been widely accepted as the definitive aspects of sustainability. In reality, this framework promised a "new era of economic growth" for all (WCED, 1987, p. xiii) that both developed and developing countries initially embraced, since they did not have to tighten their belts, but were encouraged to place economic growth as central to both development and environmental issues. This focus evolved out of the human development discourse that includes an overtly polarized world of communist vs. democratic (Cronon, 2011), human-first vs. environment-first interpretations (Wilson, 2002), and the practice of trading-off between oppositions (Gibson, 2006).

The Minister of the Environment for Canada Tom McMillan (1989) wrote soon after publication of the *Brundtland Report*,

[F]rom Gifford Pinchot to the Brundtland Commission, we have come full circle. Conservation was originally a doctrine of economic growth. Pinchot's theory of sustained yield forestry has now been broadened to encompass non-renewable resources and practices as remote from forestry as a computer is from a garden. But the principle in each case is the same: we must live off the planet's interest - not its capital. What is more, we must make the kind of investments in the planet that will ensure sustained dividends. (p. 112-3)

As Chapters 4-10 of this dissertation will demonstrate, this worldview is not founded in the science of ecology but instead is dependent on economic health.

After more than a quarter of a century since the *Brundtland Report*, it is becoming evident that the three-pillar approach has generally failed. As the World Conservation of Nature states:

There is a profound paradox here, on one hand you have the twenty-first century is heralded as the age of sustainability, with a rainbow alliance of government, civil society and businesses devising novel strategies for increasing human welfare within planetary limits, on the other hand, the evidence is that global human enterprise is becoming rapidly less sustainable and not more. (Adams, 2006)

In terms of ecosystem net loss has made the Earth *less* sustainable (Rees, 2009). While today most scientists and ecologists agree that we need to drastically reduce our environmental impact, the primacy given to efficiency-based measures and trade-offs designed to grasp low-hanging fruit and protect economic growth continue unabated. As a result, transformational changes are rarely discussed. This chapter has set up how the received sustainability framework is not designed to address the size and scope of global SES problems. An alternative framework based on the Earth as an ecosystem in which its health and well-being are in jeopardy, instead guides the systems naturalists.

The discussion in the ensuing chapters describes an alternative tradition to the human-centric and economic development discourse focus of contemporary sustainability. Sustainability is about “understanding long-term processes” that transcend generational thinking and should be examined through a historical lens and not just statistical forecasting (Redman, personal communication, 2014). Sustainability scholars interviewed have reinforced the sentiment that most do not consider the long-term history of an area. But, such an approach is problematic as historical environmental

processes are often not well documented. If we intend to make the ecosphere sustainable for the indefinite future, we must look as deep as possible into the past.

Our cultural and natural histories have long had an abstract and dialectical relationship. As Edward O. Wilson (1998) writes, “there is nothing fundamental separating our natural and cultural histories. Given that human action comprises events of physical causation, why should the social sciences and humanities be impervious to consilience with the natural sciences?” (p. 11).

CHAPTER 4: WHAT IS SUSTAINABILITY? AN ALTERNATIVE TRADITION

Now that I have described it, I will contrast the received tradition with a brief explanation of a broader, alternative sustainability tradition. In large measure, this intellectual tradition has been stimulated by a combination of super-wicked SES problems, and the work of systems thinkers and naturalists to enhance, advance, and clarify future sustainability discourse. Although not always working specifically on SES problem-solving, systems naturalists have helped build a base of knowledge that contributed to our understanding of changing climates, population dynamics, socio-ecological community dynamics, and other socio-ecological interactions that began to affect the wellbeing of both society and nature.

Our cultural and environmental history continues to shape the concept of sustainability. This alternative tradition, which offers three millennia from which to draw sustainability thinking, also provides background for the analysis of the systems naturalists in Chapters 5-10 of this dissertation, where I argue that the thinking of naturalists and ecologists, being much closer to the source of our survival, can provide a more comprehensive, scientific, and reality-based framework for sustainability.

In this chapter, I propose an alternative sustainability tradition, a tradition that reaches back much further than even von Carlowitz, and embraces the natural sciences—particularly the life sciences, ecology, and ethics regarding the natural world. This tradition is, in part, based on the reaction to emergence of historical SES problems, ecological preservation, human values, and discoveries and changes in the understanding of these problems and the sciences founded in the writings of the systems naturalists. I look at SES problem-solving as both an early and inherent goal of civilization and an ancient philosophical discourse. SES problem-solving and important concepts for educational theory (like consilience and transdisciplinarity) also have roots

in the work of proto-ecological and coupled-systems thinkers like Aristotle, Baruch Spinoza, Thomas Malthus, John Muir, and Barry Commoner.

In the second part of the discussion, I examine three *non*-UN documents written by scientists and ecologists in the 1970s and 1980s: *Limits to Growth* (1972), *The World Conservation Strategy* (1980), and *Caring for the Earth: A Strategy for Sustainable Living* (1991), as sources of a framework for the unprecedented rising consumption rates, the health of ecosystems, growth of technology, and dissemination of advancing ecological knowledge. These principles are much more congruent with the principles of systems naturalists. These three non-UN documents and the naturalist tradition also support an alternative tradition for sustainability, and a heritage that system naturalists can claim as their own. I also discuss how this alternative tradition recognizes SES problems and how it stresses systems thinking over the long-term. As SES problems stimulated the inception of this tradition, the tradition in turn developed a holistic approach to sustainability issues from all of the three branches of knowledge simultaneously. Essentially, this approach formed the center of contemporary sustainability thinking.

Historical Thinkers of the Alternative Tradition

Emergent and SES problems like climate change, deforestation, riverine, ocean and land health problems, and population and consumption dynamics which plague sustainability discourse today are as old as civilization itself. Jared Diamond (2006), Charles Redman (1999), and other anthropologists (Konfirst, 2012; Linden, 2007; Montgomery, 2012), have revealed how extreme events, soil loss, unfettered population growth, and the homogenization of natural systems have concerned scientists and ecologists (American and otherwise) for centuries. Diamond (2006), for instance, uses pre-historical Montana as an example for “all of the dozen types of problems to pre-

industrial societies in the past,” specifically mentioning “soils, water” . . .” and “climate change and biodiversity losses” (p. 35). Problems such as these should be examined and understood through both the literature and their deeper context within geological and natural history. The next discussion will examine several theoretical antecedents to sustainability and SES—or coupled human and natural systems—thinking.

Holistic Theory Origins

As Grober (2012) puts it, “sustainability is the antonym of collapse” (p. 16). This is why prehistoric cultures such as those of Native Americans developed the “seven generations” concept (Hauptman, 2008).¹⁵ Proto-sustainability concepts include the *sustenance* of the *Old Testament* (circa 1000-400 BC), and the idealistic and abstract “stability” in Plato’s *Republic* (circa 380 B. C.), referring not only to food but also to *all* human necessities including shelter, nourishment, and fuel.¹⁶

Much more to the point of our scientific and ethical traditions than Socrates or Plato—who did not study the natural sciences and were indifferent to astronomy and biology (Mumford, 1961)—was Aristotle’s (384-322) model. Aristotle’s thinking is the foundation of the scientific method, and considerably improved our way of approaching a given problem (Klein, 1990). Both Plato and his teacher Socrates originated idealistic thinking in Western thought, but he possessed virtually no understanding of the natural world to guide his philosophical concepts, values, and principles (Mumford, 1961).

Aristotle, on the contrary, invented a new form of logic that began instead with specific

¹⁵ Hauptman (2008), an Iroquois, argues that the Iroquois are the originators of *seven generations* concept, which has been useful in negotiation American-Indian relations since the 1800s, in *Seven of Generations Iroquois Leadership: The Six Nations since 1800 (The Iroquois and Their Neighbors)*.

¹⁶ *OED Bible* translation: sustenance: necessities of life; food. *The Bible*, Psalm 22:30; 78:06; 102:18. Psalms contains many citations with direct reference to the coming of future generations depending on translation Hebrew dictum to build a city, “for the edification of future generations” (Exodus 17:14; Deuteronomy 31:19).

observations from the material and natural sciences, and proceeded through experimentation and trial and error to the formulation of abstract ideas (Klein, 1990).

Huxley (2011) suggests that Aristotle is rightly placed at the origin of naturalist history because he “put natural history on par with the traditionally respectable sciences such as mathematics, medicine and astronomy” (p. 24). As a result, he was among the first thinkers to develop a notion of sustainability principles like intergenerational equity in his *Nicomachean Ethics* (350 B.C.), and to articulate sustainability’s concept of *future generations* (Aristotle & McKeon, 1941; *OED*, 2014) as well as the concept of *emergence*, an ecological concept that must be understood to analyze and solve today’s SES problems (Goldstein, 1999). Climate change, accelerating biodiversity loss, and rising consumption rates are all emergent problems that involve ethical obligations to future generations.

Roots of Non-anthropocentrism, Stewardship and Evolution

A more bio-centric view and a sense of responsibility to the environment also emerged during the High Middle Ages (1100-1300) and Renaissance (1300-1700). Grober (2012) traces the first use of the Latin *sustinento* (today’s *sustainability*) to the “Brother Sun, Sister Moon” canticles of Codex 338 written by St. Francis of Assisi (1181-1226) (pp. 36-42). Grober (2012) writes that St. Francis “makes a radical break with classical and Christian thought,” reinterpreting humankind’s relationship with nature as one of “brother” as opposed to one of “subjugation” (p. 36).

The *Oxford English Dictionary (OED)* (2014) dates the first usage of the English word *sustainable* to Randle Cotgrave’s 1611 dictionary, *French and English Tongues*, which defined it as “capable of being endured or borne” (OED, 2014). Sustainability “ur-texts” include such works as John Evelyn’s *Sylva: or a Discourse on Forest Trees and the Propagation of Timber for His Majesty’s Dominions* (1664), which predicted a

future social and economic crisis as a result of the country's shipbuilding (Grober, 2012), as well as initiating in Western history the discussion of carrying capacity (Wackernagel & Rees, 1996).

Competing interpretations of nature's purpose existed throughout the Enlightenment (1600-1800). Baruch Spinoza (1632–1677) influenced literature, representing more Eastern than Western conceptions of holism in eighteenth century Germany, and in seeing God as “Nature” in the divine sense as synonymous with God (Grober, 2012, p. viii; 36-41). Common elements propagated the idea of human beings as constituents of, and equal to, nature. This idea contravened Enlightenment thinkers like Linnaeus (1707-78)(Foucault, 1973). Linnaean thought mimicked the Platonic thought, and first description of idealism, describing the universe in terms of eternal “forms” toward which the natural world strived to become (Williams, 1973, p. 55). Because of their higher level of intellect, Spinoza framed human beings as stewards of nature (Grober, 2012).

Next, although not as well known today, the second most commonly found book in France in the late eighteenth century was a 36-volume treatise on natural history and animal behavior, *Histoire Naturelle, Générale et Particulière* (Buffon & Loveland, 1775/2004)(Farber, 2000). Its author, Georges-Louis Leclerc, Comte de Buffon (1749-1788), often considered the experience of viewing the natural world as much more unpredictable and random than Linnaeus, his rival (discussed in more detail in Chapter 6) -- with whom he was almost always at odds (Foucault, 1973). Countless thinkers since Linnaeus have argued that Nature's taxonomy was “too rich and various to be fitted within so rigid a framework” as the Linnaean model (Foucault, 1973, p. 126), based on a perfect order or divine economics that placed all plants and animals in service to human beings.

Rather than base his theories on the Bible, as Linnaeus and most Enlightenment thinkers did, Buffon relied on his own observations and on Aristotle and the Roman naturalist Pliny for his understanding of nature (Farber, 2000).¹⁷ Buffon also challenged commonly held ideologies that contravened findings in the natural world, presenting an alternative to the *Genesis* story (Farber, 2000) as well as calculating the Earth's age at about twenty times that of the Biblical 6,000 years calculated by theologians. Buffon has often been considered “the father of evolutionary theory” (Farber, 2000). Buffon instead reasoned—like Thoreau would prior to Darwin¹⁸—that quadrupeds were all related to one another (Thoreau & Cramer, 1854/2012, p. 207), and based on phenomena rather than “forms,” thus establishing proto-ecological idea of ecological roles.

Few thinkers besides Spinoza and Buffon saw human beings as part of nature, until the Romantics and Thoreau. As we will later see, their thinking is crucial to a sustainability worldview that human beings need to view themselves as stewards of the Earth and not as managers and controllers of nature—as had been established in traditional dominion paradigms like during the Enlightenment (Wilson, 2014).

Introducing Carrying Capacity

An environmental politics scholar, Paul Wapner (2010) argues in his *Living through the End of Nature: The Future of American Environmentalism*, that Thomas Malthus (1766-1834) was “one of the first and foremost voices to raise the specter of sustainability” (p. 43). Malthus may be most well-known for referring to economics as

¹⁷ Pliny the Elder (23-79 A.D.) was possibly the first environmentalist and was important for recognizing that the Empire's ecological footprint extended far beyond its borders, making them reliant on the importation of 300,000 tons of grain per year (Solomon, 2011). Farber (2000) notes that the naturalist “Pliny claimed to have studied *all* the earlier work of Greek and Roman authors, effectively combining the information to create a comprehensive survey of the natural world,” [italics added] in search of what E. O. Wilson has called “the Ionian Enchantment” (i.e., a unity of knowledge or transdisciplinarity).

¹⁸ Thoreau would have the benefit of reading Darwin's early pre-evolution works like the *Voyage of the Beagle* (1838), and referred to it in *Walden* (p. 209).

“the dismal science” (Grober, 2012; Pijawka, 2015; Worster, 1994a). But, as one of our first population ecologists, he set the stage for the modern economy as well as providing a very early understanding of how ecological limits (as well as a regional and global understanding of supply and demand) would affect the economy (Worster, 1994a).

In his essay, “An Essay on the Principle of Population” (1798), Malthus explores many existing problems of the production of food, poverty, rising consumption rates, and other touted benefits of industrialism. He states that food production grows *linearly* while population grows *exponentially*—an important point for sustainability thinking (Pijawka, 2015). This fundamental incongruity suggested that we would one day surpass the carrying capacity of the Earth, producing such outcomes as unchecked disease, famine, and war. In fact, it can be seen today that, with the current population growth and unsustainable agricultural practices, “food security” is becoming one of the critical wicked problems of our time, vindicating Malthus’s earlier arguments.

Malthus also laid the groundwork for many naturalists such as Darwin, Humboldt, and Marsh (Wapner, 2010). Worster (1994b) credits this influence for “the logic and structure of Darwin’s revolutionary ecology” and the theory behind the survival of the fittest concept (p. 114). Like Darwin, Malthus applied his ecological ideas to human populations’ competition for place. He first “introduced a new ecological dimension to Adam Smith’s study of human economics” (Worster, 1994a, p. 150). Malthus then described, “what today we would call ecological overshoot,” which is considered an introduction to the environmental movement (Wapner, 2010, p. 44).

Since the beginnings of the industrial revolution, Malthus’ importance has waxed and waned in social sciences discussions. But, Malthusian thought made important contributions to pre-Brundtland sustainability literature, including the controversial tradition of geologists such as Henry Fairfield Osborn who wrote *Our Plundered Planet*

in 1948. Other Malthusian echoes may be found in the work of economists like E. F. Schumacher who wrote *Small Is Beautiful: A Study of Economics As If People Mattered* in 1968; population ecologists Paul and Anne Ehrlich, who authored the *Population Bomb* in 1968; and of course the highly influential *Limits to Growth* and its sequels (1972; 1992; 2004). All of these works suggested unrestrained human economic development endangers the life-support systems of the Earth, not merely lowering the utilitarian levels of happiness among humans, as Malthus considered in 1798.¹⁹

Climate change and other SES problems have reopened sustainability discussions that are often characterized as “Malthusian” and “neo-Malthusian” because they involve the acceptance of the idea that the human race is outstripping its resources (Edwards & Orr, 2012; Grober, 2012; Pijawka, 2015). Malthus’s greatest contribution—that of examining the Earth’s carrying capacity—is often acknowledged, but rarely applied to actual local-to-global sustainability planning (Rees, 2006). The next thinker sought to appeal to the public from a very different perspective.

Spiritual and Aesthetic Values

Experiencing pristine wilderness when first arriving in California, John Muir (1838-1914) wrote, “Tug on anything at all and you’ll find it connected to everything else in the universe.” (Muir, 1911, p. 11). Muir, a naturalist, advocated a clearly-defined biocentric view toward the rights of nature (Minteer, 2006). One of the first people to write about the Central Valley of California, Muir dedicated a large portion of his life to documenting its biological diversity:

[G}ilias, lupines, chrysopsis, clarkia, penstemons, mint, nemophilas . . . that Muir called the valley one of the great ‘bee garden’ of California. He waded ankle-deep

¹⁹ The British economist John Maynard Keynes (1883 – 1946) is also often accredited with bringing Malthus back into mainstream discussion, as well as influencing mass production in America in the *General Theory of Employment, Interest and Money* (2006).

through the blooms, lay at night on them for a bed, shared their fragrance with the larks, antelopes, hares, and bees” (Worster, 1985, p. 9).

As with many naturalists, Muir also had an instrumental side that appealed to spiritual and aesthetic considerations as anthropocentric values. In the *Mountains of California* (1894), he wrote, “[i]f the importance of the forests were even vaguely understood, even from an economic standpoint, their preservation would call forth the most watchful attention of government,” placing the responsibility on local, state, and federal governments (p. 140). Muir pleaded with Roosevelt on several occasions to take his side over Pinchot’s—especially with regard to the grazing of sheep on the public domain. Roosevelt chose to side with Pinchot, his Chief Forester. With the damming of Yosemite’s Hetch Hetchy Valley, Muir lamented that he had not resisted the Pinchot-style notion of utilitarianism—and the idea that government management schemes would be able to preserve the wild environment—much earlier (Worster, 2008).

Muir did not subscribe to the belief that the concept of sustained-yield was sufficient to protect wildlife. He knew that although private interests and governments would espouse good intentions to arrive at a perfect system of sustainably harvesting resources, big business under a permissive government repeatedly destroyed one pristine wilderness ecosystem in California after another (Worster, 1994a; 2008). He thought the reason for the destructive power of industrialism was lack of regulation, and that with the right type regulations, the economy could be used for the *benefit* of the forests.

Muir, who understood the workings of machines almost as well as the interdependencies of ecology, knew that if the government had enforced democratic property rights and mandated a much simpler preservationist platform, they would have

greatly reduced the environmental externalities associated with the agricultural, logging, and salmon fishery booms in the West (Worster, 2008). This has been an approach that resulted in their significantly lower productivity today (Duffin, 2007; Hirt, 1994; Lichatowitz, 2009). This “scientific management” of the Progressive Era ideologies in Muir’s era that had the intention of protecting these stocks took the opposite tack in eventually helping to create subsequent market-failures (Dana & Baden, 1985). Muir would influence later naturalists like Leopold, as well as more politically oriented naturalists like Barry Commoner.

Social Ecology and Social Activism

In the post-WWII era, Barry Commoner (1917-2012) was an ecologist and social activist who had been influenced by J. D. Bernal’s social function of science concept that saw a need to link science and ethics. Commoner made it his lifetime mission.

Commoner in fact mined the deepest social philosophies of the Frankfurt School at the time. Commoner attended Columbia University in the early 1930s when the school was at the height of social activism. Many of the Frankfurt School migrated there to avoid the censorship and violence of the Nazi party. Michael Egan writes of Commoner in the *Science of Survival* (1963), “By the time he entered Harvard in 1939, Commoner was convinced of his public and political duty as a scientist to disseminate his scientific findings as broadly and as publically as possible” (p. 27). Commoner (1972; 1975) saw scientific and technological advances as violating old established norms without the recognition of the public ‘infatuated’ by the advances, saw that scholars and scientists must take on an important normative role of dissent. (Egan, 2007, p. 23)

Commoner’s activism asserted science was declining in prestige as well as giving rise to new social concerns (Egan, 2007). “To many scientists, the integrity of the

genuine search for knowledge—and the freedom to engage in that pursuit—had been irredeemably compromised by the lopsided financial support for science related to weapons research and nuclear physics” (Egan, 2007, p. 43). Commoner thought that if the integrity of sciences was not taken seriously, science could put human and societal health and well-being at permanent risk.

Research and development in chemical and nuclear science escalated rapidly after World War II.²⁰ Commoner saw the gap between science and social science widening and took it upon himself to fill that gap in the American Association for the Advancement of Science as it evolved its environmental ethic in Commoner’s era. As early as 1966, Commoner said that we were “mortgaging future generations” with our industrial practices (Egan, 2007, p. 83). Like Rachel Carson later, his contact with dichlorodiphenyltrichloroethane (DDT) research heavily influenced his beliefs.²¹

Commoner resisted what he termed Paul Ehrlich’s (1968) fierce assault on population growth; something he called the “lifeboat ethic” through distributing birth control, coercively if necessary. The debates between Ehrlich and Commoner in the late 1960s and early 1970s serve to illustrate this ongoing ideological debate and division within human development discourse. In his seminal publication *The Population Bomb* (1968), entomologist and population ecologist Paul Ehrlich advocated for immediate human population control especially in developing countries or risk depleting important global environmental resources, and increased land use as well as pollution. Commoner critiqued Ehrlich’s views on population control as inequitable and coercive toward

²⁰ In 1947, Commoner began to bring important scientific debates of high risk out into the open, as well as press the American Association for the Advancement of Science to begin to play a more ethical role (p. 32). Later in 1952, he formed the Committee on the Social Aspects of Science with Margaret Mead. Commoner and Carson inspired a wave of activism that persisted through the 1960s and early 1970s, directly influencing Albert Schweitzer in his Nobel Prize Winning Peace Prize speech to ban nuclear testing.

²¹ During WWII the Allied forces used DDT in projects which commoner was a part of like the Normandy Invasion (Commoner, 1963).

developing countries. Commoner asserted that increases in technological development and mass production were primarily responsible for the impact on the environment. Ehrlich, a neo-Malthusian thinker who located the problem primarily in population growth and aggregate consumption, was perceived as both a pessimist and an alarmist. Commoner (1972; 1975) established that science and ethics must be linked to tackle the most difficult SES problems at hand, fostering an alternative political framework that would ensure environmental and social issues like pollution and health would not take a backseat to technological advancement.

An Alternative Framework: A Non-UN Literature Sustainability Discourse

The rest of this chapter examines three concurrent and contemporary documents *Limits to Growth* (1972), *The World Conservation Strategy* (1980), and *Caring for the Earth: A Strategy for Sustainable Living* (1991)—all of which used sustainability terminology. These non-UN documents, published parallel to the UNCHE (1972), the *Brundtland Report* (1987), and the *Earth Summit* (1992), were written by some of the world's leading scientists. In an attempt to give sustainable development a more fully developed ecological platform, these more science- and ecology-based documents ironically propagated and further entrenched discussions structured around the instrumental and economics-centric focus of sustainable development. I begin by examining the *Limits to Growth* (Meadows, Randers, Meadows, and Behrens, 1972). This document argues, in a clear Malthusian tradition, that we are in danger of surpassing our carrying capacity, defined by the social ecologist William Catton in *Overshoot: The Ecological Basis of Revolutionary Change* (1982) as “the maximum persistently feasible load” (p. 4).

Ecological Limits to Economic Growth

The Limits to Growth (1972) was written by members of the international think-tank, the Club of Rome, who definitely had the Earth's carrying capacity in mind. It used the newest breakthroughs in computer science from the Massachusetts Institute of Technology and some of the earliest computer-driven statistical forecasting (Meadows, et al, 1972). Primarily an academic document, it was dedicated to solving the integrated problems of exponential population growth and pollution rates, limited resources, and the inadequacy of technology alone to meet the demands of both natural and human systems. This document was one of the first to propel the concept of sustainability, and the term sustainable development, into the global discourse on human development (Costanza, Graumlich & Steffen, 2007).

These findings were highly controversial, not just because of the political implications, but also because of the methodology and assumptions embedded in the model (Mitcham, 1995; Simon & Kahn, 1984). For developed countries, it implied that they must show constraint in production and consumption. For developing countries, it illuminated the gross inequities within countries and between the developed and developing world. As a result of its critique of consumptive patterns, it immediately received backlash from the business world and conservative think-tanks for its neo-Malthusian thinking (Cole, Freeman, Jahoda & Pavitt, 1973; Kahn & Wiener, 1967; Kahn & Schneider, 1981). While *Limits to Growth* (1972) largely framed sustainability in terms of carrying capacity over 40 years ago, subsequent UN-literature ignored its warning, framing sustainability around an economic imperative of continuous growth that is intrinsically incompatible with thermal and material laws (Rees & Wackernagel, 1996).

Limits to Growth (1972) was criticized when the discovery of numerous deposits of natural resources suspended the envisioned catastrophic consequences (Mitcham, 1995; Simon & Kahn, 1984), and 1992 came and went without collapse as forecasted. Over the forty years post-*Limits to Growth*, the writers and

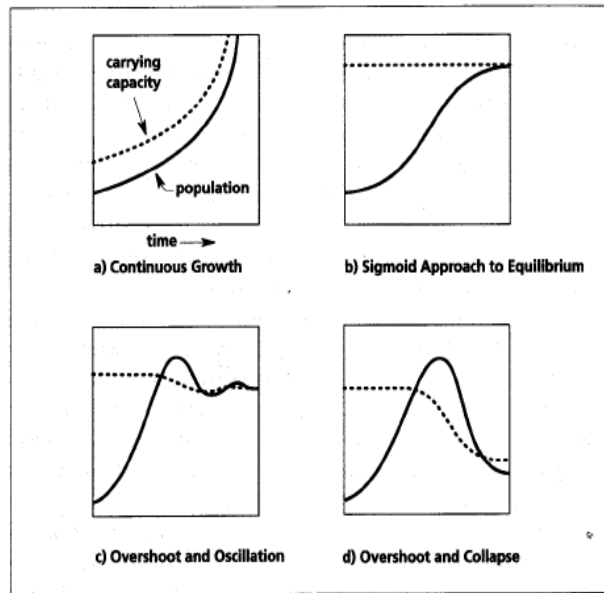


Figure C. Scenarios of Growth. In the *Limits to Growth: The 30-Year Update* (Meadows, Randers & Meadows, 2005, p. 158).

systems-thinkers suggest that the second two scenarios (i.e., c. and d.) presented in the second update, *Limits to Growth: The 30-Year Update* (Meadows, Randers & Meadows, 2005), seem the most likely. Neither of the last two scenarios allows for continuous growth in a world of finite resources. In their follow up document, Meadows, Randers & Meadows (2005) reiterated their predictions with only slight variations in the outcomes in many cases. *The Limits to Growth* (1972) and its follow-up articles have used well-known ecological principles to suggest that sustainability must be about cutting back our net impact, not just on the individual or community level but at national, regional, and global scales. Thus it would serve us well to remember, as population ecologist Lester Brown (2011) put it, that “economic and social collapse is always preceded by a period of environmental decline” (p. 9).

Despite the fact that the predictions did not materialize, the authors’ concepts of ecological populations as a function of available resources, and the relationship to carrying capacity, can be easily understood using the x/y graphs in Figure C. Scenario a)

shows population keeping pace with the Earth's carrying capacity. In this scenario, resources are abundant and/or efficiency will exponentially multiply their availability. Scenario b) shows that we have not yet reached the global carrying capacity and the population will smoothly level off—an unlikely scenario according to most sustainability scholars (Brown, 2011; Condon, 2012; McKibben, 2010; Rees & Wackernagel, 2012). Scenario b) is also unrealistic in that it demands signals from physical limits to the economy to be “instant and accurate.” Scenario c) shows that we have passed the carrying capacity and that signals and responses are delayed. This is likely the condition we now face. Finally, scenario d) depicts where carrying capacity is exceeded, forcing a reduction in natural resources and lowered carrying capacity both of which are irreversible (p. 158).

Most sustainability initiatives do not have such a transformational vision in mind, and therefore, do not meet the scale and magnitude of the problem at hand. If we are to achieve sustainability in a world that is quickly surpassing—or has already surpassed—carrying capacity, the work of systems naturalists suggests actionable solutions. Sustainability scholars have argued we must go beyond economically based success measures such as triple-bottom lines and tradeoffs that make us ever more efficient but fail to reduce our net impact (Jamieson, 1998; Norton, 2005; Walker et al., 2004). The systems naturalists provide a model for making this transition.

The IUCN's Endorsement

The *World Conservation Strategy: Living Resource Conservation for Sustainable Development* (1980) was authored by the International Union for the Conservation of Nature (IUCN), also known as the World Conservation Union. Established in 1956, IUCN was the preeminent body of global ecological preservation and conservation (Mebratu, 2001). The group's mission, as laid out in *World*

Conservation Strategy (1980), targeted “living resource conservation for sustainable development” (p. 18), opening the door for the term’s universal use in dialogues about the environment.

Unlike the *Brundtland Report*, the *World Conservation Strategy* (1980) primarily tackled difficult environmental issues such as diminishing biodiversity, climate change, natural resource depletion, and endangered species. It defined humans in ecological terms as a significant “evolutionary force” (IUCN, 1980, 3.1) and set sustainable development as the new socio-ecological interface to handle a score of problems that threaten the survival of ecosystems around the world.

The endorsement of the term “sustainable development” by biologists, chemists, and ecologists—scientists dedicated to the study of natural systems—helped underscore sustainable development as centered on (1) living resource conservation, (2) the maintenance of essential ecological processes, (3) the preservation of genetic diversity, and so forth. In fact, the *World Conservation Strategy* named scores of SES problems that sustainable development could address, but with the understanding that the findings by the world’s top environmentalists and ecologists would set limits for developers.

While sanctioning the concept of sustainable development, the authors of the *World Conservation Strategy*, expressed this caveat:

[T]he separation of conservation from development together with narrow sectorial approaches to living resource management are at the root of living resource problems. Many of the priority requirements demand a cross-sectorial interdisciplinary approach. (IUCN, 1980, 8.6)

Shortly after the *Brundtland Report*, the IUCN reaffirmed sustainability again in *Caring for the Earth: A Strategy for Sustainable Living* (1991). This time, however, they

began by very clearly stating that development was necessary and not the opposite of conservation. In this document, SES problems and biological principles seemed to be secondary (IUCN, 1980). Biologist John Robinson's (1993) rebuttal in the journal *Conservation Biology* has characterized it as "middle-of-the-road thinking" (p. 21). Robinson (1993) argued that the goals and principles of human development and ecological health as stated in *Caring for the Earth* were "incompatible" (p. 21) and that the document still placed sustainable development on a pedestal. It did so without providing an analysis of how to develop sustainably.

The IUCN (Adams, 2006) may have regretted the decision to validate sustainable development later, saying, "The Brundtland definition was neat but inexact.... In implying everything *sustainable development* arguably ends up meaning nothing" (p. 3). The IUCN (2006) criticized the general sustainability discourse as well, saying,

There is a profound paradox here ... On one hand you have the twenty-first century is heralded as the age of sustainability, with a rainbow alliance of government, civil society and businesses devising novel strategies for increasing human welfare within planetary limits, on the other hand, the evidence is that global human enterprise is becoming rapidly less sustainable and not more. (p. 3)

Yet despite these reservations, the *World Conservation Strategy's* approval of the concept of sustainable development by the scientific community helped the sustainable development paradigm continue.

Sustainability Becomes Science

Sustainability became a formalized science when the National Academy of Science (NAS) published *Our Common Journey: a Transition for Sustainability* (Kates & NRC, 1999), which echoed the language in "Our Common Future" and stressed sustainable transitions with a "normative vision." The concept of normative vision was

important because it contained an ecological ethic that relied on crucial scientific facts regarding the changes in the biosphere. These facts were a substantial part of that ethic, going far beyond previous ethics of economic and technological equity between developed and developing countries.

Our Common Journey (1999), which was written by scientists, links the ideals of the *Brundtland Report* to the real world. Reminiscent of the *Limits to Growth* (1972), the second chapter outlines the historical trends of population, economy, resource use, and pollution, recognizing humankind as an ecological force and begins to shape the planet in terms of changes to the life support system. More important, the authors of *Our Common Journey* do not constrain its normative vision to instrumental values and natural capital, instead outlining its premier mission as protecting water, air, and land resources.

While these resources were acknowledged as vital for human beings, and thus instrumental, these reports revealed the declining health of ecosystems as vital to the survival of life as a whole, and not just as resources geared towards increased wealth. Thus, the document's foundations are not only social and technological but also biological and geological (Kates & Clark, 1999), helping to link sustainability more formally to the SES problems that can drive society's collapse. With this shift, the term *sustainability* replaced *sustainable development* as the central focus (Grober, 2012).

As Kates and Clark (1999) state in the preface, an emerging *sustainability science* should

focus on the dynamic interactions between nature and society, with equal attention to how social change shapes the environment and how environmental change shapes society. These movements seek to address the essential complexity of those interactions, recognizing that understanding the individual components

of nature–society systems provides insufficient understanding about the behavior of the systems themselves. They are problem-driven, with the goal of creating and applying knowledge in support of decision making for sustainable development. Finally, they are grounded in the belief that for such knowledge to be truly useful it generally needs to be “coproduced” through close collaboration between scholars and practitioners. (p. 1)

This report linked natural and social systems and sustainability theory and practice much more realistically. It is one of the first to establish reporting methods through the use of “indicators” of human and land health, as well as establish and develop sustainability as a science (Clark & Dickson, 2003).

In recent decades, scientists Robert Kates and William Clark (1999) and many others have expanded this work. In addition, important research bodies, like the NAS, have recognized SES as inextricably intertwined with this new transdisciplinary science that examines pivotal wicked problems, such as the decline of land health in the form of ecosystem diminution, agricultural soil erosion and depletion, and annual biodiversity losses at a rate estimated at 100 to 10,000 times past extinction rates (Wilson, 2002).

An Alternative Tradition: Discussion and Conclusion

Historical systems-thinkers like Aristotle, Spinoza, Buffon, Malthus, Muir, and Commoner provide an alternative tradition and framework for sustainability thinking. Aristotle, Spinoza, Buffon, and Muir offer important integrative, ethical, and evolutionary perspectives for sustainability thinking. Malthus was interested in the long-term economic stability, the limitations on health and happiness imposed by available resources, and the likelihood of SES collapse in the form of famine, disease, and war. He interpreted humans as members of an ecosystem in economic terms possibly for the first time, and centered long-term well-being on a region’s carrying capacity. The naturalist

Muir (like Thoreau) offered an extension of Spinoza's biocentrism, to one of spiritual and aesthetic values for the betterment of humankind. Environmental historian Donald Worster (1994a) claims Malthus introduced ecology to classical economics. While Malthus' viewpoint was primarily instrumental (Worster, 1994a), his thought is essential to sustainability discussions for its early understanding of the component of carrying capacity. Commoner became a contemporary advocate and activist for the environment, bringing science and ethics together in a public forum. The carrying capacity of ecosystems and the ecosphere also becomes central to a vein of literature that runs parallel to the *Brundtland Report* and other UN literature, but frames sustainability and SES much differently.

An alternative post-WWII narrative for sustainability and sustainable development also exists. In the 1960s and 1970s, academics, industry leaders, and governmental officials in developing and developed countries alike began expressing a deep and universal concern for the exhaustion of natural resources albeit for different reasons. Economists, who understood the implications for human society, echoed Malthus's concerns about the world's rising levels of population and consumption. This resulted in the creation of a wide spectrum of academicians, governments, and organizations dedicated to the protection natural systems for human benefit (Mebratu, 2001).

For instance, M. King Hubbert (1903-89), who was working for Shell Oil at the time, coined the concept of "Peak Oil" and predicted rapidly diminishing reserves (Hubbert, 1956). Around the same time, the authors of *Our Plundered Planet* (1948), *Silent Spring* (1962), *The Population Bomb* (1968), and *The Closing Circle* (1971) issued early cries for awareness regarding endangered species, pollutants and pesticides, and humanity's exploitation of the global environment (Hay, 2000; Sale, 2002).

UN literature and international conferences, spanning from the 1970s to the present, tell conflicting stories. UN documents trace the term sustainable development from its first use in the early 1970s to its centrality in environmental discourse in the late 1980s, and comprise what I call the received tradition. *Limits to Growth* (1972), the *World Conservation Strategy* (1980), and *Our Common Journey* (1999), on the other hand, depict sustainability as the mechanism to protect the Earth's coupled human-nature system from severe SES problems. Together these distinct yet complementary documents tell the story of sustainability's rise from a virtually unknown concept to the leading term in development discourse. Only recently, when sustainability became known as sustainability science, did it truly begin to tease out a gamut of values that have made it irreplaceable in contemporary environmental and policy discourse.

This discussion of an alternative tradition for sustainability has presented examples of ancient vulnerabilities and proto-sustainability thinkers. These early ideas and traditions are vital to sustainability discourse, but are often not included, or glossed over (or only given cursory coverage) by most sustainability science authorities. The contemporary tradition of international conferences also has an alternative tradition to the received tradition centered on the *Brundtland Report*.

The lack of a sustainability discourse that has included the subtleties of a natural and cultural historical sustainability discourse may be why economics has often been viewed as the dominant of the three pillars. So while we extol sustainability's economic-based principles, e.g., efficiency, trade-off negotiating, transparency, local economies, etc., we often ignore long-standing sustainability principles derived from a more holistic and complex range of normative, scientific, cultural, aesthetic, and ecological values (Jamieson, 1998; Norton, 2005; Walker et al., 2004). Since its induction as the central organizing document of sustainability discourse, the *Brundtland Report* (1987) has

subsumed environmental discourse as simply one of three pillars, and led to continued western models of human dominance over nature (Worster, 1994ab). It has also framed sustainability as a compromise between conservation and growth, pitting them against one another.

Now that I have discussed how SES problems have helped shaped society, and how society has sometimes unwittingly contributed to major SES problems, I will present some of the largest contemporary SES challenges of sustainability discourse, followed by the applicable principles of systems naturalists for the resolution of such problems. In the following chapters, I will describe why theoretical trade-offs, despite being almost always necessary on some level, should not guide sustainability thinking. The next six chapters will historically present the roots of the problem, as well as the roots of the solution throughout history through the lens of systems naturalists, as I discuss in the next two sustainability theory chapters.

CHAPTER 5: INTEGRATION OF HUMAN AND NATURAL SYSTEMS (PRINCIPLE #1)

One of our greatest socio-ecological system (SES) challenges today is the warming of the Earth's atmosphere. The great majority of international scientists confirm that since the Industrial revolution, humans have increased the amount of carbon dioxide (CO₂) in the Earth's atmosphere to levels unprecedented over the past 800,000 years (IPCC, 2014; Pew, 2012). Recently, researchers also found that global climatic change is occurring at a rate at least ten times faster than any change in the past 65 million years (Stanford, 2013). While historically changing climates have subjected societies to great shocks, this time humans have shocked the climate, which has scores of cascading effects for human systems. The projected effects of this unprecedented global change in human history include the likely creation of an estimated one billion climate-change refugees (Assadourian, 2010).

The effects of climate change are not limited to human beings, however, but will contribute to the destruction or impairment of ecosystems vital to our life-support systems. According to the Harvard School of Public Health (2014), which also sees biodiversity loss as a serious threat to cities, "Climate change alone is expected to threaten with extinction approximately one quarter or more of all species on land by the year 2050, surpassing even habitat loss as the biggest threat to life on land" (p. 1). Unfortunately, climate change is only one of a number of significant sustainability challenges that the world faces in the twenty-first century.

Purely economic thinking and purely anthropocentric thinking lead us to make poor trade-offs, while systems naturalist thinking could help us make better decisions and trade-offs. Viable solutions intertwined SES challenges like climate change, biodiversity loss and rising consumption will require mastery of not only ecology, but also the many known areas of the sciences, social sciences, and humanities (Kates &

Parris, 2003; Wilson, 1998; 2014). In many cases, however, the science that supports efforts to protect ecosystems has taken a backseat to theories that either stress economic growth or water it down in an effort to balance environmental initiatives with socio-economic goals (Sarewitz, 2003).

This may be, in part, because current deep sustainability theory has replicated 1) the older theoretical and ethical assumptions that science can be separated from ethical decisions, and 2) that our only ethical duty is to human beings. Environmental philosophers and ethicists have often characterized this as an anthropocentric (human-centered) worldview. This is in direct conflict with a non-anthropocentric, or bio-centric (life-centered), eco-centric (ecological-centered) worldview that places all living things at the focal point. This parting of visions among the populace, naturalists, and within environmentalism itself has created a critical division on the proper use of nature in Western culture in the Enlightenment (Worster, 1994a); within the conservation movement²² in the early part of the twentieth century (Minteer, 2007; Norton, 1999); during the environmental movement of the 1960s and 1970s (Costanza, 1991); and within modern sustainability discourse (Du Pisani, 2006).

How can a re-examination of traditional naturalists' thinking expand and improve sustainability's theoretical framework to make it better represent human and natural knowledge and values? I suggest systems naturalists' coupled-system worldview can diffuse unrealistic and myopic ideologies, common to many political and religious stances intended to continue business-as-usual scenarios of production and consumption without endangering our life-support systems and ourselves. A new

²² "Conservation" is a much richer term in the hands of many conservation biologists like Wilson, advocates today like Curt Meine, and environmental ethicists like Minteer (2006) and Norton (2005) who incorporate elements of the moral regard for nature that we think of as defining the preservationist position. Many naturalists have identified themselves as conservationists when they clearly had this richer and less utilitarian mode in mind.

relationship that nurtures restoring and preserving these systems and our natural resources on an individual-to-global-level like that of the systems naturalists is both philosophically and scientifically plausible in the twenty-first century. Systems naturalist theory, in opposition to the ongoing ideological beliefs that continue to plague sustainability today, entailed a worldview of one coupled cultural and natural system, which is as applicable for solving socio-ecological problems today.

The chapter is divided into two parts, as is each chapter of Chapters 5-10 that comprise the body of the dissertation. First, I present the current challenges in sustainability theory and a background description of the historical and problematic ideologies that persist within it. Next I cite examples of how systems naturalists (in this case Thoreau) overcome these problems.

Problematic Ideological Roots

Thus far, the concept of sustainability has not ably captured pluralistic values (Kates, & Parris, 2003) and it has also failed so far to resolve the longstanding conflicts among environmental worldviews, e.g., *Arcadian vs. imperialist* (Worster, 1994), *preservationist vs. conservationist* (Minteer, 2006; Minteer & Miller, 2011), and *environmentalist vs. economist* (Wilson, 2002) (Figure D). The academic studies below reveal a common and polarizing pair of ideologies that still seem to dominate Western sustainability discourse. At one end of the spectrum is an environmentally driven approach that emphasizes conservation and precaution, and gives rise to small-scale and ecologically-based solutions. The opposing paradigm tends toward a more technocratic and cornucopian approach. It is primarily market- and growth-driven, stressing the management of risk and technological innovation (Costanza, 1991; Kates & Parris, 2003; Conway, Keniston, & Marx, 1999; van der Hamsvoort & Latacz-Lohmann, 1998; Worster, 1994a). This ongoing polarization may be due in part to a Brundtland

sustainability framework being centered on a very impractical and contradictory compromise between environmental conservation and economic growth, interpreted by many scholars as an oxymoron (DuPisani, 2006; Kates et. al., 2005).

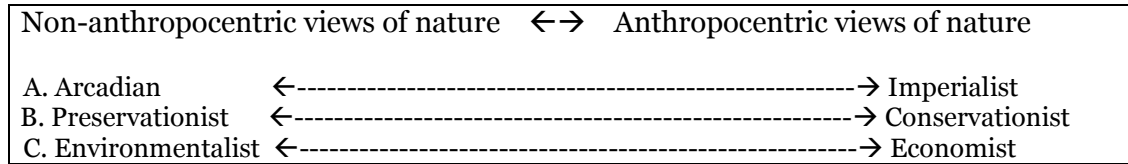


Figure D. Environmental Polarizations. A.) historical thinkers of ecology (Worster, 1994a); B.(early American environmentalists (Minteer, 2006); and C. the generalized and ongoing polarization today (Wilson, 2002).

In the face of concrete knowledge to the contrary, many anthropocentric ideologies have argued against the rights of ecosystems in favor of human development, such as the 25-year campaign against climate change by United States conservatives (Hoggan, et al. 2009). Ideologies of US liberals may have done almost as much harm by suggesting an incremental and gradual shift to renewables would solve all our environmental problems (Klein, 2013). The social scientist and urban ecologist Jane Jacobs (2005) argued that the ideologies are fundamentally flawed and unfavorable whether they come from either side of the political spectrum in framing both problems and solutions.

While this religious conviction is much less overt today than it was throughout most of our history, it has persisted across many ideological stances (*Guardian*, 2010; Hoggan et al., 2009). Such positions do not possess a worldview capable of supporting a sustainable human relationship to earth systems imperiled by climate change, biodiversity loss, and rising consumption rates. But Wilson views our non-scientific reasoning as cutting closer to the bone of ecological science:

Among the most virulent of all such cultural parasite-equivalents is the religion based denial of organic evolution. About one-half of Americans (46 percent in

2013) most of whom are Evangelical Christians, together with a comparable fraction of Muslims worldwide, believe that no such process has ever occurred . . . Evolution is a fundamental process of the Universe, not just in living organisms but at every level. (p. 183-4)

Wilson suggests that this deep, ideological legacy contravenes another critical naturalist tradition of linking science with philosophy, ethics, literature, art, and religion, for which no other system naturalist I know of is better positioned to address—by Wilson’s (1998; 2015) own standards—than Thoreau. These humanities fields, when viewed in isolation from the natural world, almost entirely overlook the real world causes and conditions. Historically, these fields have often reduced complex data and phenomena to idealistic and overly simplistic definitions of the human-nature relationship.

The next background discussion, therefore, examines a form of holism, epitomized by the philosopher Plato. His ideas are based on abstract thought alone without science, and a subsequent human-centered ethic that contributes to the current anthropocentric views in UN literature. It will be followed by an alternative explanation of holism—defined by Thoreau as the meeting place of philosophy and science (Walls, 1995; Yeo, 2003) to guide sustainability theory.

Idealistic Holism

Idealism as a philosophy is defined by Oxford dictionaries (2014) as, “any of various systems of thought in which the objects of knowledge are held to be in some way dependent on the activity of mind. Often contrasted with *realism*” (Oxford, 2014). Because of the latter part of this definition, one can already begin to see how idealist perspectives might not mesh with SES problems, since environmental and sustainability discourse has a tradition evolved from real-life environmental problems (Minteer, 2011; Cole & Foster, 2001). Cultural theorist Raymond Williams (1973) defines *ideology* as a

pejorative term, as “abstract and false thought, in a sense directly related to the original conservative use but with the alternative—knowledge of real relationships and conditions—differently stated” (p. 155). In other words, ideologies are “false consciousness, illusion, unreality, upside-down reality . . .” (Williams, 1973, p. 156)

Since antiquity, scientists and philosophers aspired to describe the fundamental laws of the universe in terms of *holism* (discussed fully in Chapter 1). Holism that is limited to the disciplines of either philosophy or science exclusively, however, can become dangerously reductionist. *Reductionism* is defined as “a procedure or theory that reduces complex data and phenomena to simple terms.” It is another pejorative term that describes a theory that holism is married to an idea of two worlds—one spiritual and ideal, the other corporeal and material (Merriam-Webster, 2013).

While idealism prevents our scientific observations of the natural world from informing our worldview, *too* scientific a holism, limited by the confines of a single field of science or method, also denotes an incomplete and unbalanced approach, or “the attempt to explain all biological processes by the same explanations (as by physical laws) that chemists and physicists use to interpret inanimate matter” (Merriam-Webster, 2013). Here, I argue that both the idealistic and the scientific definitions of holism illicitly ignore certain sets of data for the sake of simplicity and to keep all variables in agreement. On the idealistic side, this preserved many ideologically based beliefs; on the scientific side, it shortchanged values and culture, reducing them to purely scientific or naturalistic phenomena.

My interpretation of Platonic thought contrasts with that of political scholar Melissa Lane (2011), who argues that Plato’s vision of a “shared standard of value for society” can guide sustainability theory (p. x). I posit instead that although idealist perspectives may be important to the social pillar of sustainability, idealistic ideologies of

our planet as subservient to an ethereal realm of ideas has historically obscured and overridden the natural sciences to leave us with the depleted, exhausted, and overpopulated world we have today.

Plato (428-348), in fact, could not read a map; his urban planning skills were viewed by later scholars as disgraceful (Mumford, 1961). But Plato's deficiency was effectively corrected by the first naturalist (arguably the first *systems naturalist*), Aristotle (384-322 B.C.), who resisted the Platonic notion of a world based on forms. In direct opposition to his teacher, Aristotle reformed what a worldview could be, showing it could operate in congruence with (and as part of) the natural world (Klein, 1990).

These two antagonistic philosophical views of western thinking are indelibly represented in Raphael's (1483-1520) late Renaissance painting "The School of Athens" (c. 1509) (Most, 1996). In it (see Figure E.), Plato is pointing upward to represent the world of ideas, the intangible, induction alone, and the purported perfection of early mathematics (since the figures go from left to right in chronological order). On the right, are scientists who come after Aristotle, who motions toward the Earth representing the world of natural laws, botany, chemistry, physics, and the scientific method. But, I posit only Plato's worldview is ideological. This painting captures the conflicting ideas as guiding Western discourse.

Plato is also "pointing upwards beyond the limits of pagan philosophy toward an eventual Christian revelation that he alone can vaguely sense" (Most, 1996, p. 165). This fundamental difference in worldview has been at the root of ideological debates ever since, especially among Enlightenment thinkers who thought to synthesize the Greek's foundational work with the teachings of the *Bible*.



Figure E. Plato vs. Aristotle. The late Renaissance painter Raphael contrasted two different worldviews—one spiritual and one material—that contributed to Western civilization to that point (Wikicommons, 2014).

In Chapter 6, I will demonstrate how the normative Christian ideas, values, and principles of the day would be tacitly idealistic, Platonic, and orderly (Farber, 2000; Worster, 1994a). As I discuss next, the systems naturalist Thoreau challenges the ideological ethics and worldviews by grounding philosophy, ethics, and the humanities in general in the natural sciences.

Thoreau and a Coupled-Systems Worldview

Today, as the science of ecology has become increasingly more specialized, its practitioners—in their examination of biological and chemical minutiae—often do not have the expansive opportunity to apply their findings to the “big picture.” For example, many biologists often devote years (or even decades) to studying one species, and ecological models provided by the UN are often based on this type of individuated, linear analysis. And, it should be noted, many scholars in the humanities are not scientifically literate. The truth is most sustainability scientists do not understand how to supplement their science with the humanities (e.g., ethics, religion, history, and literature) (Minteer, 2011). Likewise, well-meaning, humanities-based environmentalists often exhibit only a

smattering of knowledge from the sciences and its inherent complexities. In contrast, a truly holistic sustainability scientist understands the holistic origins of SES challenges as well as how to supplement the knowledge with that of the humanities.

In opposition to static, Platonic, and unscientific thinking, the systems naturalists of this dissertation instead look to answers about the condition of all living things, and consequentially advance a worldview of one coupled system. As the roots of Western sustainability theory begin with forest succession (Caradonna, 2014), I will begin by examining some writing of perhaps the first American systems naturalist, Henry David Thoreau (1817-1862) who spent a lifetime devoted to the issues of forest succession (Howe, 2009). Through Thoreau's conception of the natural world and our place in it, he links the sciences and humanities for a more holistic, ecological, and ethical sustainability paradigm.

Unlike the other systems naturalists, Thoreau had the advantage of attending the university at a time the naturalist Wilson (1998) now (retrospectively) covets, before divisions in disciplines and specializations were not as narrow, and at a time when the Romantic Movement (1790-1830) had publically challenged views of Enlightenment (1600-1800) thinkers (Walls, 1995; Worster, 1994a). This discussion will concentrate on (a) Thoreau's natural philosophy, (b) his realist philosophy, and (c) his full use of the scientific method to develop a revolutionary view of holism that prescribed a new relationship between human and nature to counter what he perceived as our nation's growing ills. His views were contrary to Platonic-, Enlightenment-, and Puritan-based concepts of the roles of science and nature, and by his uniting of theories of knowledge from the natural sciences and humanities, his approach can guide the integration of science and ethics in sustainability discourse.

Natural Philosophy

Thoreau, an American pioneer in coupled-systems thinking, can guide sustainability discourse today. Thoreau's major at Harvard—"Natural Philosophy"—was the product of a time when scholars still searched for a unity among all the laws of the sciences and the humanities (Walls, 1995, p. 6; Wilson, 1998, pp. 59, 73, 91-3, 292-294; Wilson, 2014, p. 38). This was a precursor to the natural sciences, and had implications for philosophy, metaphysics, and what we might today term *ontology*, or the study of being. This educational foundation was designed to make a student robustly well versed on cultural and natural history, including poetry, literature, theology, classic Greek mythology, astronomy, optics, zoology, and electricity—among other blossoming subjects of the sciences and humanities (Walls, 1995, p. 6).

Many scholars have noted the influence of the Romantic Movement on Thoreau (Norton, 2003), often going as far as calling him a Romantic (Nash, 1973; Worster, 1994a). Thoreau's writing certainly bore elements of Romanticism. German Idealists responsible for beginning the Romanticism in Europe derived much of their views on holism from Chinese and Hindu philosophy in its original Sanskrit. Thoreau himself is credited with the first translation of Eastern philosophy in America (from German), the Lotus Sutra (Albanese, 2012). Thoreau closes his "Economy" chapter in Walden, as Taylor (1996) notes, with a story about the only tree that could be said to be truly free, the cypress—because it produced nothing of human value. I posit this quote is most likely a reference to Chuang Tzu's, "The Useless Tree" (circa 350 B.C.) translated in *The Way of Chuang Tzu* (Merton, 1965, p. 45-6).

The German-influenced Romantic Movement (1790-1830) in England and Transcendentalism (1825-1840) in New England decried urbanization and industrialization, the end products of rational Enlightenment thinking espoused by Rene

Descartes (1596-1650), John Locke (1634-1702), and Isaac Newton (1642-1726).

Romantics censured overdependence on science and reason, and lamented the serious social and economic side effects of industrialization. They countered the mechanistic aspirations of the Enlightenment by venerating principles such as the Lord Byron's (1788-1824) autonomous individuals, Samuel Taylor Coleridge's (1772-1834) organic theory, and William Blake's (1757-1827) depiction of alienating materialism and industrialism (as well as illustrations of its abuses to women and children). These authors told stories of protagonists who found emancipation from the mundane factory life through their imagination and escape into Nature with a capital "N," signifying the ideal and divine, but not in traditional Christian terms (Albanese, 2012, p. 1). Such ideas helped to form the tenets of Transcendentalism.

Unlike Puritans who viewed the natural world as a "moral vacuum," environmental historian Roderick Nash argues that Transcendentalism, "reject[s] deist's assumptions about the power of reason" (Nash, 1973, p. 84; 86). Human beings, according to Transcendentalism, were not separated from nature as in the structured form of the Enlightenment paradigm, they were rather *part of* nature in the Romantic worldview (Emerson, 1979b). Thoreau's writing that followed shortly after this period helped form the American Renaissance (c. 1850-70), the first flourishing of the humanities in "New World" to receive international recognition, which included Herman Melville (1819-91), Ralph Waldo Emerson (1803-82), Nathaniel Hawthorne (1804-64), and Emily Dickenson (1830-86).

Thoreau and his New England neighbors became some of the first to make a significant contribution toward the ongoing European literary and cultural discourse (Mumford, 1926; Matthiessen, 1941; Reynolds, 1998). As global trade flourished on a new level, with crossing the Atlantic becoming almost commonplace in his lifetime,

Thoreau participated in an ongoing, though somewhat elite, European discourse on human civilization (Matthiessen, 1941; Tanka & Baym, 1998). Thoreau went further than his counterparts (many of whom similarly to Emerson, were only amateur naturalists) by diversely founding his work on biology, early evolutionary theory, and forest succession (Howe, 2009; Worster, 1994a).

Thoreau's unique version of Transcendentalism differed from the projects of other thinkers such as Emerson in that it was a philosophy —or worldview— that resisted the dogma of the Puritan tradition and Harvard University, which founded its religious studies on the beliefs of the Unitarian church. As Norton (2003) argues, “Thoreau ultimately rejected Emerson's Platonism because he could not understand nature in terms of fixed essences. Thoreau thus chose Heraclitus over Plato, ‘All nature is in flux’” (p. 34). But while Norton suggests that Thoreau did not “provide a clear connection between science and values” (p. 39), I argue that Thoreau's most important observations stem from this unification.

Thoreau embodied a traditional nineteenth century naturalist, as first and foremost a field biologist, and second a student of natural history, as one who took his findings in nature and placed it in the larger scope of things. He never relinquished his humanities side, however, and within the context of natural history, wrote daily about his literary, ethical, and religious thoughts. However, upon reading his work, it immediately becomes obvious that he holds both the empirical sciences and philosophy in equally high esteem, “a fact;” he wrote, “... will one day flower into a truth” (Thoreau & Cramer, 1839/2012, p. 12). In *Walden: or Life in the Woods*, he constantly weaves between observation and philosophy, knowing that ethics can change the understanding, as easy as a change of facts might drastically alter one's ethical response:

We must learn to reawaken and keep ourselves awake, not by mechanical aids, but by an infinite expectation of the dawn, which does not forsake us even in our soundest sleep. I know of no more encouraging fact than the unquestionable ability of man to elevate his life by a conscious endeavor. It is something to be able to paint a particular picture, or to carve a statue, and so to make a few objects beautiful; but it is far more glorious to carve and paint the very atmosphere and medium through which we look, which morally we can do. To affect the quality of the day, that is the highest of arts. (Thoreau & Cramer, 1854/2012, p. 536)

Many scholars have downplayed or overlooked Thoreau's work as a scientist. "Thoreau wasn't trained as a scientist and wasn't systematic . . . he was not really a naturalist" (Redman, personal communication, 2014). But others, like Norton (2003) clearly locate him in an important place in the development of naturalism and ecology. After all, Thoreau worked for many years under the famed naturalist Louis Agassiz (1807-73),²³ trying to unlock the secrets of forest succession through the sciences of natural history and geology. Thoreau, like Buffon with Linnaeus, frequently found himself at odds with Agassiz -- particularly as Agassiz saw a divine order as forming the species. Not coincidentally, Agassiz was "scandalized" in 1859 by the theory of evolution, and spent many years arguing against natural selection and "conceiv[ing] the universe as a vision in the mind of God" (Wilson, 1998, p. 40).

In part because of his academic training (Walls, 1995), Thoreau did not latch onto common ideologies, freeing his thinking to take its own, unique direction. Other scientists and naturalists in Thoreau's time were searching for the principles of

²³ Agassiz is included in many naturalist anthologies for his many contributions to the expansion of the natural history museums, which became the center of the field of ecology later in the century in Boston and other East coast cities (Walls, 1995).

interconnectivity in the yet-to-be-discovered field of ecology. For example, Prussian geographer and naturalist Alexander Humboldt (1769-1859), who also rebelled against Linnaean and mechanistic view of nature, organized plants according to moisture rather than by genus alone (Worster, 1994a). Humboldt's four principles were "(i) explore, (ii) collect, (iii) measure," and "(iv) connect" (Walls, 1995, p. 98).

Like Humboldt's and Aristotle's holism, such thinking would guide Thoreau's synthesis of his observations in nature and intertwine them with Western philosophy. His philosophical and social views were framed by the connections between these two worlds. Kuhn (2009) writes that Thoreau would seek to conciliate "oppositions such as nature and culture, self and other, reason and feeling, in addition to science and art" (p. 3). Yet, despite his command of natural sciences, Humboldt has proven less influential than Thoreau as "literary grace usually eluded him" (Walls, 1995, p. 102), as few are adept at expressing ecology in ways that most human beings can relate to other than systems naturalists.

Even Thoreau's most romantic notions were often founded in direct observation and experimentation that far exceeded the understanding of his Romantic and European counterparts. In fact, the source of America's first recognized environmental ethic did not originate in philosophical abstracts but through observation of the considerably more complex natural world and the experiment at Walden Pond. Norton (2005) says of Thoreau that he "believed morality to be subject to the same methods as he used in deciding how to manage a forest or a deer herd" and defined naturalists (including Leopold) in part by this attribute (p. 90).

Literary scholar Laura Walls (1995) relates this attribute in Thoreau to his ability to utilize both *rational holism*, which stemmed from the Enlightenment principles and could only be comprehended by meditation upon the divine, and its complement,

empirical holism, “which could only be understood through interconnections” (p. 6).

While Thoreau, like the other Romantics, largely turned his back on the methods of Enlightenment thinkers in the poetic retreat into nature, he nevertheless was a Christian and on a quest for spirituality. Thoreau believed that a philosopher-scientist-artist could unite object and subject, surpassing in proto-ecological worldview the Romantics who viewed nature primarily as an object of awe, inspiration, and mystery, and further they rejected the idea of a God that was separate from nature.

He believed, like Spinoza (see Chapter 4), that God and nature were synonymous; and, that human beings’ bodies and minds were part of nature and subject to its laws. Also like Spinoza, Thoreau rejected the teachings of the churches, agreeing that “the idea that ‘God made all things for man’ and that ‘there is a ruler of the universe . . . who has arranged and adapted everything for human use’ is a prejudice” (Grober, 2012, p. 54). This, as Grober (2012) demonstrates, has special import for sustainability discourse, as it turns the traditional Linnaean order on its head, placing the responsibility for the stewardship of the Earth in the hands of humans rather than a divine creator.

Although Thoreau’s “science” is often criticized, his annual observations on the flowering of many plant species from 1851-1858 have provided baselines for recent climate-change studies, and the deterioration of ecosystems over the last 200 years in New England (Primack, 2014). Furthermore, when combined with his socio-economic views, Thoreau embodies the citizen scientist who consistently seeks to develop this trait in all members of the community (Havens & Henderson, 2013). I suggest it is Thoreau’s unique holism, which balanced the sciences and the humanities, that shaped the first American sustainability ethic as one firmly grounded in both the natural sciences and philosophical/social discourse. This is largely because in Thoreau’s philosophy, nature

was divine and held important philosophical notions for the application of science because of a change in the relationship between God and nature, which I discuss next.

Consolidating the Cartesian Split

William Paley's (1743-1805) theories in *Natural Theology* (1802) are representative of Enlightenment ideals in Thoreau's time, which described a static world where the natural world functions as a limitless cornucopia to human beings through human reason and divine providence (Worster, 1994a). For Romantics, the opposite was true, the natural world presented a mystical and subjective world open for the viewer to interpret with passion and emotion. As Thoreau formed his own transcendentalist ideas about philosophy and science, he openly criticized Paley²⁴ in the 1830s and 1840s.

For Thoreau, Transcendentalism was a philosophy that went beyond the Cartesian dualism between mind and body, subject and object, spirit and nature that had been problematic in Western philosophy and science until that time.²⁵ Whereas the Romantics stressed mystery and awe in a sublime nature that was described as the outward representation of God and often defied explanation, Transcendentalists believed in an achievable union of these dualities from which to draw their principles (Nash, 1973). While Emerson's transcendentalism believed nature to be the outward manifestation of God (much like Plato), Thoreau did not agree. He viewed it *as* God (Worster, 1994a). But to describe Thoreau strictly in romantic terms is a mistake.

Many scholars have noted the obvious influence of the English naturalist Gilbert White's (1720-1793) *The Natural History and Antiquities of Selborne* (1789) on Thoreau

²⁴ Thoreau (1949) also criticizes Paley's social views in "Civil Disobedience," and Paley's chapter in *Natural Theology* called "Duty of Submission to Civil Government." Thoreau originally entitled the article, on the contrary, "Resistance to Civil Government."

²⁵ Transcendentalism, like its predecessor Romanticism, also had a global perspective, owing homage to Eastern religious ideas of holism and interconnectivity, and specifically ideals for the optimum relationship between government and the individual. Early in the nineteenth century, German Idealists began referencing Chinese classics like Lao Tzu's (circa 481-410 BC) *Tao Te Ching* for its view of the interconnectivity of all life forms as "spirit."

(Howe, 2009, pp. 397-404; Walls, 1995; Worster, 1994a, pp. 58-66). White (1789) tied philosophy and science through direct observation and respect for nature. White's reverence for the mundane in nature, down to the level of the humble earthworm, is mirrored in Thoreau's detailed descriptions of muskrats, grass, cicadas, and even ice (Worster, 1994a). But Thoreau did not reflect White's views on providence, which viewed the human relationship with nature as static and instrumental (Worster, 1994a).

Thoreau's era preceded the division of what would be described later by chemist and novelist C. P. Snow (1959) as the "two cultures," the sciences and the humanities (Wilson, 1998, Yeo, 2003). As discussed briefly in the last section, Walls' (1995) main thesis contended that Thoreau had the unique ability to engage in this cross-discourse, and that this is his defining quality. I assert that since Thoreau, the biologist and natural historian, had an ethic that viewed nature and humans as interrelated, he was a masterful synthesizer among multiple disciplinary ways of knowing. This aspect of his thinking, as I describe next, could greatly benefit sustainability today.

The Scientific Method and Inductive Reasoning

Thoreau, like Aristotle, employed a scientific method that equally valued both inductive and deductive reasoning. Thoreau believed that "to the extent a culture, or an individual, lost contact with wilderness it became weak and dull" (Nash, 1973, p. 88). While Thoreau's understanding of the ethics of the wild have been hard to pinpoint, most Thoreau scholars have acknowledged it as part of his very high standards for individual, cultural, and national morals. Howe (2009) defines Thoreau's term "Genius" as a "systemic method" (pp. 397-404). "His writings reveal a holistic worldview which seeks to understand how everything in nature interacts almost purposefully to produce a harmonious and self-sustaining whole. Yet his scientific observations drew from his interest in the mechanistic philosophy and inductive approaches to studying nature"

(Howe, 2009, p. 399). It is a method that can be used to unite principles from the three spheres of sustainability.

Thoreau's philosophy may be the first in the United States to not only value the wild in nature and "half-savage" in men, but also to decry human destruction of the environment which included the Native American culture (Nash, 1973, p. 94). Though many argue that Thoreau's ideal was not really the wild, but the pastoral (Taylor, 1996), Thoreau's respect for places untouched by human beings, Native American knowledge, and criticism of what many considered idyllic Concord, suggest an intrinsically non-anthropocentric worldview. Although Worster (1994a) argues that Thoreau was a textbook Romantic, I hew closer to Wall's (1995) interpretation, i.e., a reading that sees Thoreau as more of a romantic scientist who viewed nature as containing the answer to philosophical conundrums. I also concur with Nash (1974), who likens Thoreau's thinking to James Fennimore Cooper's legendary frontiersman and moral hero Natty Bumppo as believing human beings "should alternate between wilderness and civilization" (p. 95).

Thoreau (1854) might say instead that poetry was often the medium through which (what today we would call) coupled systems were viewed and portrayed. Like postmodernists today, he might believe that as Clark (2012, p. 20) writes, "knowledge moves by metaphor." A journal entry from around the same time as *Natural History* reads:

[F]acts must be learned directly and personally, but principles may be deduced from the information. The collector of facts possesses a perfect physical organization, the philosopher, a perfect intellectual one... [the poet] generalizes the results of both—he generalizes the widest deductions of philosophy (Thoreau, 1905, p. 60).

In the above passage, Thoreau describes inductive principles as valuable as actual facts. Inductive reasoning goes beyond facts so that what is summarized in the conclusion is not among those stated in the premises (Pierce & Moore, 1998). Induction enabled him to develop philosophical implications from the world of science. For example, he wrote, “Elasticity and flexibleness in the simpler forms of animal life are the equivalent to a complex system of limbs in the higher” (Thoreau & Cramer, 1839/2012, p. 50). He also recognized that forests were not static and could take hundreds of years to regain their original biodiversity after being disturbed (Miller, 2009).

Though the systems thinking of evolutionary science and modern ecology had not yet developed, Thoreau intuited properties of forest succession and evolution from the study of botany and natural history that exceeded the boundaries of either at that time (Clark, 2013). Thoreau’s thinking, which incorporated emergent properties that develop out of particulars but when assembled represented something larger than any of those individual findings, was akin to Darwin’s thinking. In fact, *Walden; or, Life in the Woods* (1854) is anticipatory of Darwin’s *Origin of the Species* published in 1859.

Throughout *Walden*, Thoreau’s transcendentalism underlies his deepest concepts, values, and principles that address a range of topics including economics, individualism, conservation, forest management, ethics, religion, literature, botany, and geology. Thoreau (1839) expresses himself with metaphor in many cases where the scientific term had not yet been conceived (Walls, 1995). Throughout his work, he describes nature and society in complementary terms but with great concern, as when society gravitates away from its connections to the natural world -- which he considered “society’s balm” (p. 6). Thoreau’s morality, science, and overall aesthetic ultimately lay between the logic of reason and the ecstasy of the poet, requiring him to develop his own ideas through philosophy and ethics in order to express his worldview.

Thoreau has often been misunderstood as a defender of a bio-centric ethic because of his deep exploration of the local environment and his cultural contributions have been underestimated (Minteer, 2011; Taylor, 1996). Although Worster (1994a) is correct in placing him in the Arcadian tradition, Thoreau primarily appeals to the Greek Aristotle rather than core Romantic and pagan tradition on worship of supernatural and sublime powers. His early view of the world as one coupled system links philosophy, science, metaphysics, and physics with the study of the human and natural worlds. As literary scholar and leading eco-critic Lawrence Buell (2009) writes, we cannot “make sense” of Thoreau’s passages “without reference to natural history and/or cultural ecology” (p. 37). Thoreau, in fact, rarely wrote an article, let alone a paragraph, in which the subjects of human systems and ecological systems were not overtly and inextricably intertwined.

Integration: Discussion and Conclusion

Hard facts did not interfere with, or depreciate, Thoreau’s “striving to relate natural fact and human values opens rifts, perplexities, and chastening question, even as it celebrates the natural world in its very illegibility as a scene of moral speculation” (Clark, 2012, p. 34). Minteer’s (2006) recounting of Thoreau’s near “obsession” with dispelling myths of bottomless ponds in the area proves reveals his empirical side (p. 97). However, it was not only because of his biological skills but his criticism of the Romantics who sought to reinstate a Greek and pagan view of the sublime, that make Thoreau’s viewpoint applicable over a century and a half later. Unlike Romantics who experimented with alchemy, unconscious writing, reviving cultural myths, and beliefs in supernatural powers, Thoreau was much more soberly rooted than those in the world of empiricism.

Most aspects of an idealistic paradigm include, (or tacitly imply) governance by a Christian God. Such idealistic thinking rendered this world as a temporary and transient one -- perhaps even a testing ground for, or a mere shadow of, another world of spirit (Mooney, 2006). While this is a kind of holism, it is not the kind of thinking that should guide sustainability discourse. Instead, naturalist thinking that begins with scientific fact and proceeds to abstract thinking should be an underpinning to the approach to sustainability discourse.

Contrary to Platonic and Enlightenment-based thought, human beings according to Transcendentalism were not separated from nature, but part of nature (Emerson, 1979b). Generalizations among the sciences and the humanities allowed Thoreau to embrace science—the medium through which the natural world could be analyzed and interpreted—and simultaneously probe deeper questions left unanswered by the Romantics. Though Thoreau has often been misunderstood as a bio-centrist (as described by Minteer, 2011), and downgraded as a scientist as Taylor (1996) points out, it is only in understanding his applications of science to philosophy, of nature to culture—and vice versa—that Thoreau’s later trip to Walden Pond as an artist’s venture and meditative exercise on nature and society begins to make sense. Like his friend and naturalist Emerson, Thoreau believed only an “Artist” and master of both science and philosophy could combine intuition with empiricism (Emerson, 1979a), allowing them to understand the emergent concepts beyond the typical biologist or philosopher.

Thoreau’s thought can enhance sustainability through his coupled-system thinking and his encouragement that all members of a society should become citizen-scientists in order to develop a greater respect for nature as the source of spirituality and the key to individual and societal development (Havens & Henderson, 2013). It also

grounds sustainability in real-life problems by eliminating abstract arguments that avoid facing the realities of living in world of finite resources.

Naturalists, as our first scientists, ecologists, and field biologists, have written extensively from the foundations of physical and material conditions. To derive findings in more abstract fields like ethics, philosophy, and cultural history, naturalists relied on their direct observation of natural phenomena and mined natural history. Such efforts provided them with a “long view” on SES and sustainability problems that is requisite in order to achieve constructive sustainability thinking and education. More important, however, has been the naturalist’s holistic imperative to apply their findings to the greater whole of not only the natural sciences, but the social sciences and humanities as well (Wilson, 1998).

A worldview of one coupled system must have an ethic/value system (Norton, 1991). Systems naturalists suggest it is only through effective and timely efforts to understand and respect the environment and our place in it within a sustainable and ecologically grounded worldview that we can both achieve the *Brundtland Report’s* mission of preserving the natural world for future generations, and the ecological goal of preserving the planet’s delicate balance and harmony achieved through billions of years of evolution.

“We have a tendency to turn away from complexity under all conditions . . . it is easier to place ideas into dichotomies than to understand the nuances of a situation” (Redman, personal communication, 2014). Too much generalization usually means reductionism and ideological thinking. Many sustainability scholars seemed to agree that the concept of trading-off was akin to ideological polarization (to be discussed below). While ethical viewpoints seem to produce the most controversy among environmentalists and sustainability theorists, Aldo Leopold’s proto-sustainability

theory overtly dismisses ideological beliefs. Instead of ecocentrism or anthropocentrism, Leopold argues for a “non-anthropocentric anthropocentrism” (Callicott, 1999, p. 127)—never even attempting to separate instrumental and intrinsic values, in the realization that we are inevitably only human--which I will discuss in the next chapter.

CHAPTER 6: A PARADIGM OF INTERDEPENDENCY (PRINCIPLE #2)

The social ecologist Murray Bookchin (1921-84) argued that we cannot be anything other than anthropocentric, since we are in fact humans. The key, Bookchin thought, is in what we as humans choose to do, i.e., how we choose to interact with the rest of nature (Byck, personal communication, 2014). Whether we call ourselves "biocentric" or "ecocentric," these views describe a superior form of our unavoidable human-centered view (Byck, personal communication, 2014).

Deep sustainability theory—or the sustainability paradigm—has not developed in a manner congruent with the complexity of SES problems (Walker et al., 2004), nor does it respect the sophistication of contemporary science and ethics. Yet, solving coupled-system problems requires uniting theory and practice, as well as linking minute, individual actions in the present to collective consequences that may manifest many generations in the future (Clark, 2012). Capturing a fuller array of human and environmental values is essential to meeting SES challenges.

But the spectrum of normative sustainability values is often not identified or considered (Jamieson, 1998). Many scholars have expounded on the systems naturalists' *non-anthropocentric* views alone. But, both Thoreau and Aldo Leopold's (1887-1948) ideas are grounded in anthropocentric values. Leopold suggested that "the wild" was capable of producing in human beings the "new level of consciousness," and "change in morality" required to become the best human being, who, in turn, would consume less and want to protect nature (Norton, personal communication, 2014). In this dissertation, I posit that Thoreau and Leopold were neither anthropocentric nor non-anthropocentric—and especially not a compromise of the two. They described both a human dependency on the natural world, and the natural world's dependency on us as its stewards, for health and wellbeing. This eco-/anthro- ethic grew out of the

understanding of natural history and humankind's place in it. It defined who we are, and contained the desire to preserve and restore biological integrity whenever possible, in the face of an increasingly mechanized age.

The concept of sustainability “must be both scientific and ethical” (Vucetich & Nelson, 2010). Many discussions within contemporary sustainability discourse, and educational theory, however, seem to have ossified around the creation of local-scale indicators derived from the *Brundtland Report's* three pillars, and reinforced by follow-up reports such as *The Johannesburg Declaration* (WSSD, 2002)(Adams, 2006; Ludwig, Walker & Holling, 1997). Coalescing all of the variability contained within sustainability discourse into three basic pillars does not capture the complexity of integrating our science, social science, and humanities knowledge systems. Because the *Brundtland Report* does not articulate *what* is to be sustained or for *how long*, a number of scholars have characterized this construction as simply too ambiguous to be useful—for reasons scientific, social, historical, economic, and ethical (Hopwood et. al., 2005; Kates et. al., 2005; McKibben, 2009; Newton & Freyfogle, 2005; Jamieson, 1998; Kates & Parris, 2003; Norton, 2005; Solow, 1993; Vucetich & Nelson, 2010; Walker et. al., 2004).

Leopold's ethic builds on Thoreau's idea of nature as divine, but with a much more refined understanding of ecology and evolution, he is able to more fully elaborate upon the implicit duty of human beings to nature. While Thoreau dearly respected nature and carefully described its value for human beings, Leopold had also seen more destruction to the environment, and on a much larger scale, which enabled him to be more specific in his criticism of conservation and scientific management in his time.

In this chapter, in agreement with a number of environmental historians (DuPisani, 2006; Radkau, 2008; Worster, 1985; 1994), I first argue it was the Western,

idealistic, Christian, and mercantile capitalist worldviews that have historically promoted environmentally destructive behavior (Cronon, 2003; Merchant, 2007; Nash, 1973; Worster, 1994a). I then show how Leopold’s ethic of interdependency in *Sand County Almanac* (1949) expressed his awareness of the inherited problem of what I call “Dominion thinking,” and which he theoretically ameliorated.

Problematic Dominion Thinking

While the UN-based framework is based on “trading-off” among pillars, not enough emphasis has been placed on re-envisioning the knowledge and institutional systems that caused such problems in the first place (Redman, personal communication, 2014), and the values and deep cultural beliefs driving unsustainable practices. Rather, sustainability and SES problem-solving should be designed to meet the demands of natural and socio-economic values alike (Walker, Holling, Carpenter & Kinzig, 2004).

Politicians, industrialists and consumers in developing and developed countries alike—despite the obvious and increasing degradation to the global environment since the beginnings of industrialism (McNeill, 2000; Mosley, 2010)—have sought to maintain this system through vague notions of “sustainable growth” that have virtually no basis in reality (Constanza, 1997). This may be an inherited legacy, or an ongoing problem of dominion ideologies, which circumvents a more advanced ethic of interdependency.

Enlightenment thinking and interpretations of the *Bible*, which entailed a perfect abstract realm of God’s laws that presided over natural laws, were Platonic and “Neoplatonist influenced” (Worster, 1994a, p. 42). Plato’s view of God was certainly different than what predominates today.²⁶ God existed in a realm of perfection and order, much like the later Christian paradigm, “When he [God] was framing the

²⁶ Literary scholar Harry Wolfson (1947) writes, “Plato treats God either as one of the ideas, a supreme idea, the idea of good, or as above the ideas, a Demiurge who cannot, however, but be of the same nature as ideas” (p. 233).

universe, he put intelligence in soul, and soul in body, that he might be the creator of a work which was by nature fairest and best” (Plato & Lee, 1360 B.C./1977). Plato in fact had invented the concept of a “Great Chain of Being.” This belief, which persisted through the Christian dark ages and into the Enlightenment, held that there was a golden chain that connected Heaven and Earth (Mumford, 1961, p. 178) and that there was a “perfect” spiritual world, which the corporeal and real world only mirrored.

The following discussion examines the Enlightenment (1600-1800) thought through the perspective of Linnaeus. This is represented next by Enlightenment paradigm which has (i.) hierarchical theories of humans above nature, (ii.) form over function, (iii.) theories of providence, and (iv.) progress defined only in the continuous increase of prosperity and wealth (McKibben, 2006; Wilson, 1998; 2002; 2006; 2014), for which Leopold’s development of an interdependency ethic is the antithesis and antidote.

Hierarchical Thinking

In the Christian hierarchy, God was placed at the top over Man, who in turn ruled the myriad species through the capacity to reason. For this aim, Worster (1994a) labels Linnaeus as part of the “Imperialist” tradition while calling three of the naturalists featured here (i.e., Thoreau, Leopold, and Carson) and others like them “Arcadian,” for “advocating a simple humble life for man with the aim of restoring him to a peaceful coexistence with other organisms” (p. 2)(see Chapter 1, p. 11). Worster’s (1994a) thesis ably categorizes naturalists, but I argue their holism is much more scientific than pastoral, as Arcadian implies. Linnaeus perceived ecological systems as top down and static, with taxonomical structures of plant and animal species that “had not changed since their creation” (Farber, 2000, p. 11).

Medieval historian Lynn White's (1907-1987) seminal essay "The Historical Roots of our Ecologic Crisis" in 1967 was one of the first to advance the despotic and dominionistic reading of the Judeo-Christian tradition as *the* key worldview driving destructive environmental practices. Idealism in the eighteenth and nineteenth centuries Christian paradigm directly referred to Platonic idealism, and that "supposed ideas were fundamental, whether the divine or universal Idea or Ideas, or the constitutive ideas of human consciousness" (Williams, 1973, p. 152). The Enlightenment thinker Carl Linnaeus (1707-78) who was the first to elaborate on the animal and plant species echoed Plato's voice in the Christian paradigm in *Philosophia Botanica*,

All the species recognized by Botanists came forth from the Almighty Creator's hand, and the number of these is now and always will be exactly the same, while every day new and different florists' species arise from the true species so-called by Botanists, and when they have arisen they finally revert to the original forms. (Linnaeus & Ransbottom, 1751/1938, p. 197)

Linnaeus was representative of a type of holistic thinking common during the Enlightenment that was based on Platonic ideals, but that was *not* reflective of the principles of a systems naturalist. Worster (1994a) writes of "Linnaeans," "their ambition was to establish, through the exercises of reason and hard work, man's dominion over nature" (p. 2). Linnaeus believed similarly to Descartes (and many Enlightenment thinkers) that the material world mirrored the spiritual world in having a perfect and static order that "had not changed since their creation" (Farber, 2000, p. 11). Descartes also epitomizes hierarchical thinking by arguing that animals feel no pain (Worster, 1994a). This separate plane of existence reflected the spiritual laws, which could be discovered through reason (Farber, 2000; Worster, 1994a).

Form over Function

One of the cultural theorist Michael Foucault's (1926-84) sub-hypotheses in the *Order of Things: An Archaeology of the Human Sciences* (1975) is that idealistic Linnaeans often choose form over function, energy exchange, and phenomena. The word "species" is even a translation of the word "form" or idea (Dennett, 1995, p. 36). This conceptualization of the natural world as form-specific—one adjacent to and equally complex spiritual world—has often led society to take from the environment without considering long-term consequences, and has been one of Western society's ongoing organizing characteristics until the postmodern era (Foucault, 1973).

The study of ecological science, however, as something new and interdisciplinary in the twentieth century, represented a break from form toward the link to true knowledge, which is *not form*, or human "use," as Linnaeus described it, but function and phenomena as described by the contemporary understanding of a species' niche or role in an ecosystem (Foucault, 1973, p. 130).

The Problem with Providence

The conception of an orderly world endowed human beings with an inherent providence, or "the protective care of God or of nature as a spiritual power" (Oxford, 2013). Linnaeus's use of the root "sustain" in 1775, in *Oeconomia Naturae* (translated as *The Economy of Nature*) is representative of his thoughts on the relationship of God, Man, and Nature under the organizing principle of providence—as well as one of the more telling expressions of Enlightenment views of what today we would call sustainability.

[A]n order of nature, that some animals should be, as it were, created only to be miserably butchered by others, it seems that his Providence not only aimed at sustaining, but also keeping a just proportion amongst all the species; and so to

prevent any one of them increasing too much, to the detriment of men, and other animals. For if it be true, as it is most assuredly, that the surface of the earth can support only a certain number of inhabitants, they must all perish, if the same number were doubled or tripled. (Linnaeus & Stillingfleet, 1775/2009, p. 40)

Linnaeus realized too many of any one particular kind of species—even humans—could create an imbalance in nature, even to the extent of threatening a highly theoretical carrying capacity. God had therefore built into the system—not made humans responsible for—maintenance of a “just proportion,” which absolved them of responsibility for the care of the natural world. The naturalist Georges-Louis Leclerc, Comte de Buffon especially ridiculed this interpretation (see Chapter 2). Such an ideal of providence was either stated or implicit in much early naturalist literature, such as in Gilbert White’s understanding of a socio-ecological system (see p. 93), which thinkers like Thoreau, Matthus, and Leopold would all later reject (Worster, 1994a).

Economic Growth and Expansionism

Linnaeus’ belief that Nature’s “oeconomy” was the “divine government of the natural world” (Worster, 1994a, p. 38) led to, as Worster (1994a) argues, the “fundamental assumption ... that the ‘economy’ of nature is designed by Providence to maximize production and efficiency” (p. 52). Furthermore, Linnaeus linguistically and theoretically linked ecology to economics through key concepts like *producers*, *consumers*, *equilibrium*, *mosaic*, and *metabolism* in *Oeconomia Naturae* (1775) (Farber, 2000 Worster, 1994a).²⁷

²⁷ Xenophon’s *Oeconomicus* (384 B.C.) first established irrigation and agricultural harvests as the ecological foundation of mercantilism, allowing for the expectation of continual expansion (Glacken, 1975, p. 13). But, innovations in the sciences and technology of the times—including slavery—also created capacity for energy-deficit spending and repeated economic bust and boom cycles. Global urban studies scholar Joel Kotkin (2008), however, has argued that the physically rocky coasts that helped form important trade routes, created a progressive and “healthy” competition among the Greek states.

Following in this vein, Foucault (1973) famously argued that economic domination is inherent in the language of ecology itself. Worster (1994a) has argued that this “economy of nature” concept cast “Nature” as existing and functioning under a perfect set of laws governed by God the “Supreme economist” for the benefit of “Man” (p. 37). Despite the fact that many people stopped believing such a sentiment long ago, planners often act as if this is the case, allocating resources for human use only. During the same time period, Worster (1994a) argues that like Linnaeus, Adam Smith, the Scottish economist, also viewed nature as “no more than a storehouse of raw material for man’s ingenuity” (p. 53).

Ecological economist Gary Lynne (personal communication, 2014), however, called the way the “classical economic system” had been interpreted through American history “a straw dog,” and portrayed it as one-dimensional, warning against using Adam Smith as the epitome of that straw dog for the model of endless economic growth. Smith, in fact, devoted a good portion of his writings to arguing for equity among economic partners as a sustainable means of ensuring a healthy economic system in the *Theory of Moral Sentiments* (1759). Smith (1776) nonetheless felt that the pursuit of wealth—and the ability to manage the land to produce increasingly more—would naturally lead to the greater good of society:

[T]he most opulent nations, indeed, generally excel all their neighbours [sic.] in agriculture as well as in manufactures; but they are commonly more distinguished by their superiority in the latter than in the former. Their lands are in general better cultivated, and having more labour and expence [sic.] bestowed

However, this economic development simultaneously led to soil erosion from mass agriculture projects and the subsequent “fragmentation” of competitive Greek city-states (p. 20).

upon them, produce more in proportion to the extent and natural fertility of the ground. (p. 5)

Smith's *Wealth of Nations*, published the same year the United States officially became a country, revolutionized economics by describing the national income in terms of labor, land, and capital instead of the gold in the king's coffers. It set the stage for what is now called "classical economics," ascribing a very narrow definition of the individual as a consumer. But the economical valuing of labor, land, and capital glorifies exploitation and consumption of natural resources, as well as oddly reflects the three pillars social, environmental, and economic pillars. If neoclassical capitalism has subsumed sustainability as some claim, this would seem to be a valid analogy.

In summary, sustainability seems to have inherited four ideals of dominion and hierarchy. First, the ideal of providence excused human beings from being caretakers of their environment. Second, dominant notions of progress and expansion framed the understanding of the field of ecology itself. Third, the idea of forms that rigidly restricted species by their appearance rather than their functioning within an ecosystem, prescribed a narrow set of values. And finally, God ensures the maximum productivity of plants and animals. The systems naturalist Leopold, next, answers these Christian and mercantile capitalist worldviews, from both within the Christian ethical tradition and as a scientist, to provide a sustainability ethic of interdependency between human and natural systems.

Leopold's Development of an Interdependency Ethic

Here I demonstrate how Leopold, with a much more advanced understanding of biology, ecology, geology, and environmental management than Thoreau, had an even more developed holistic view. Leopold's worldview reinterpreted inherited ideals of

dominion and provided an authoritative voice for preservation and restoration in the United States.

The spread of industrialism, and more efficient machines throughout the first half of the twentieth century made the disruptions to ecological harmony much more apparent than in Thoreau's time. Thus, Leopold interpreted contemporary ecology dynamically like Thoreau, but with greater emphasis on its fragility and on ecosystems in which each part is dependent on all the other parts. Although Callicott (1993) has argued that Leopold's philosophy was fundamentally non-anthropocentric, I suggest that Leopold held a dual eco-centric *and* anthropocentric ethic based on evolutionary biology and ecology (an argument compatible with that of Minter's (2006) and Norton's (2005) views on sustainability practices).

I also argue that, in theory, Leopold did not compromise between these two ethics, but synthesized the principles of non-anthropocentrism and anthropocentrism. For example, in *Sand County Almanac: And Sketches Here and There* (1949) (*SCA*) and other works on conservation, he proposed a theory of restoration and preservation of the landscape that refuted the compromise between Muir's preservationist and Pinchot's conservationist views (described in Chapter 3), and favored restoring and preserving biodiversity as most beneficial to humans and nature alike.

Leopold, who had the benefit of many breakthroughs in ecological science since Thoreau's era (including the theory of natural selection), produced an ethic that reinterpreted the Christian worldview of nature as typified by Linnaeus into a comprehensive and contemporary human/nature ethic, and coupled system worldview. He challenged Enlightenment principles, replacing the hierarchy of man over nature with an ethic of interconnectivity; replacing providence with a value of stewardship; replacing scientific management based on "increasing the wealth of the nation" with

practices based on socio-ecological health and integrity; and replacing abstract ideals of “forms,” with ecological functions and the roles of species that can guide sustainability theory.

Interconnectivity, Not Hierarchy

Idealistic and non-scientific holistic ideologies that are not grounded in real-world problems and scientific findings from the natural world include *American exceptionalism* (McKibben, 2006; Nash, 2007; Pielke, et. al, 2007). American exceptionalism, which has its foundation in Enlightenment principles, and has interpreted the “New World” or “American West” as qualitatively different than past European civilizations and is the product of God’s providence, has a history that dates back to the Puritan and idealist ethic (Bacevich, 2008; Koh, 2003; Worster, 1994a). This idea contains the worldview that one’s country and people do not need to conform to nature’s rules, norms, or standards (Koh, 2003). I assert that in reaction to such views, Aldo Leopold challenged the idea that our economic and security needs are significantly more important than our—or our planet’s—health and wellbeing, and overturned hierarchical views of the Enlightenment paradigm of God over Man, and Man over nature.

Leopold’s avocations at Yale University were not limited to wandering the local forests and marshes on ornithological walks, but they also involved attending Bible study with his fiancée (Meine, 1988). His deep interest in adhering to its tenets would drive him to formulate, like Thoreau, an ethic for the environment (Meine, 1988). Leopold’s ethics would eventually center on his ecological understanding of interconnectivity of human and natural systems and combine this non-anthropocentric and anthropocentric worldview for the sake of both the human and natural world.

Like Thoreau, Leopold also had a wide background and much of his life was devoted to living a very intimate relationship with the land (Meine, 1988). But, while Thoreau and Leopold both viewed nature as providing the necessary experience of self-actualization required for an ethic, Leopold more clearly articulated the moral duties to the environment once an individual or a culture reached a higher level of consciousness through the knowledge provided by ecological science. He derived these duties largely out of respect for the field of ecological science, calling it “the outstanding scientific discovery of their twentieth century” (Leopold, 1947, p. 190), and therefore integrated it with Christian teachings, reinterpreting the ethics of the Bible.

He developed this philosophy in *Fundamentals of Conservation of the Southwest* (1923), quoting the Bible’s book Ezekiel,

Ezekial seems to scorn waste, pollution, and the unnecessary damage of something unworthy—as something damaging not only to the reputation of the waster, but to the self-respect of the craft and the society of which he is a member . . . It is possible that Ezekiel respected the soil, not only as a craftsman respects his material, but as a moral being respects a living thing. (p. 94)

Later Leopold weaves Biblical thinking to Ouspensky’s theories on ecosystems and the idea of the world as a living thing with the Christian idea of God and the Earth being “indivisible” (p.95). Ouspensky’s definition of a living thing, portent of James Lovelock’s (1979; 2005) Gaia Theory, views the earth as a single self-regulating organism. Leopold (1949) and Lovelock (1979) alike pointed to the relatively short time that man has been on Earth in the face of geological time, placing human beings more directly in the space of temporary leasers of a land which is immortal in comparison (Callicott, 2014). As a practitioner of ecology and a well-respected academic who expanded upon—as well as challenged—many of the principles he learned from the Pinchot school of forest

management, Leopold mastered an understanding of local and national conservation issues and developed his understanding of ecology, like Thoreau, largely based on the science of forest succession (Meine, 1988). Although Leopold initially espoused Gifford Pinchot's vision of intensive scientific management, his later views embraced simplicity and the preservation of the wilderness (Callicott, 1988; Minter, 2006).

By the time Leopold began what he thought would be a career in the United States Forest Service in 1909, even popular literature in biology, nature writing, and ecology presented ideas scarcely dreamed of by those in Thoreau's time. For instance, Charles Darwin (1809-1882) had convinced the world that humans had descended from primates over eons through natural selection, and philosophers questioned the established order of God, humankind, and nature in the universe. So, while Thoreau's philosophical pronouncements are likely more profound in his era, Leopold capitalized on the great changes in science to better explain the moral duty of stewardship in a vein similar to "scientific contextualism" (Norton, 2003, p. 176).

Function over Form

A number of works influenced Leopold's understanding of scientific contextualism. The publication of *Our Vanishing Wildlife: Its Extermination and Preservation* (1913) by William T. Hornaday (1854-1937) had a profound effect upon Leopold, inspiring him early in life to work to preserve his hunting and ornithological haunts from boyhood (Meine, 1988). The Russian ecologist P.D. Ouspensky's (1878-1947) *In Search of the Miraculous* (1923) impacted Leopold by revealing the "interdependent function of the elements" in nature, and a vision of relationships between the inhabitants of the natural world that went far beyond their past characterization in ecology (Meine, 1995, p. 214). Finally, leading ecologist Fredric Clements (1877-1971) had described ecosystems as "complex organisms," as well as in

terms of delicate interactions and functions (what eventually defined ecology as a science) and almost infinite interactions occurring between biotic and abiotic life (Kingsland, 2005, p. 148). Similarly, these interactions were also seen as mirrored in economic systems. Further, modern ecologists recognized socio-ecological systems (SES) were to be intimately intertwined (Norwood, 1987).

This change in the ecological paradigm contributed to shifting and expanding the hierarchical view of species to a view of species interactions within ecosystems as a web, which did not imbue preference to human beings (Kingsland, 2005). For instance, it was found that what were considered minor species often had cascading effects on ecological regimes and interdependencies often determined the health and longevity of an ecosystem's regime, which human beings seemed invariably to disturb and change (Worster, 1985; 1994a). As an accomplished forester, Leopold worked in what was in the Progressive era the wildest part of the country and saw the concept of interdependency firsthand. He worked with many branches and divisions of the national forest management system, as well as side-by-side with local farmers, giving him the ability to understand the wide range of human-natural relationships that could either help or harm ecosystem integrity. It is out of his understanding of ecological interdependency that Leopold's historically simplistic concept of the ethical evolution emerges, but it is a value system Leopold is determined to place within the context of Western and Christian traditions.

The Opposite of Providence

As stated in the last section, Thoreau's transcendentalism was much more like the providence of Spinoza's, who "declares that God and nature are one in the same thing," and who subsequently reinterpreted providence as the duty of humans to be the "guardians" of nature (Grober, 2012, pp. 53-5). Leopold similarly revered nature as a

source of personal and community knowledge and spirituality while remaining overtly Christian (Norton, 2003). However, by the time Leopold came along, the level of fundamentalism common to Puritan communities in Thoreau's time had lost its primacy.

Christian ethics, which Leopold (1949) often intertwined with his many articles devoted to the stewardship of what he considered to be the sacred creation of God, nevertheless were still a part of American culture in his era (and continue to be):

Conservation is getting nowhere because it is incompatible with our Abrahamic concept of land. We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect. There is no other way for land to survive the impact of mechanized man, nor for us to reap from it the aesthetic harvest it is capable, under science, of contributing to culture. (p. viii)

Leopold saw our ecosystems—and our own wellbeing—in perpetual jeopardy from lack of stewardship, and having witnessed the loss of healthy ecosystems on a much greater scale than Thoreau, often criticized the conservation movement of his era as off-track (Callicott et al., 2011). In response, he specifically developed a preservationist and restorationist ethic that incorporated Christian philosophy, with strong influences of Darwin and contemporary ecology.

The environmental philosophers Callicott and Norton (the latter points to the notion of *normative sustainability* discussed in Chapter 6) have had an ongoing debate over whether Leopold's ethic was ultimately non-anthropocentric or anthropocentric in character. In short, I agree and disagree with both. They both in some sense see Leopold as reconciling previous conservation and preservation stances. I partly disagree with this reading, in that Leopold leans more to the preservationist view—and the restorationist stance where preservation cannot be achieved—than Norton (2005) and Minter (2006)

suggest. But I agree with them both to the extent that Norton, while delving deep into theory, is speaking of Leopold's life practices rather than his deep personal belief.

Callicott (2014) observing Leopold's "exposition and promulgation of an evolutionary-ecological worldview and its axiological and normative implications speaks more of the deep theory, and positions Leopold's center—and especially the theory of general practices in *Sand County Almanac* (1949)—more squarely in the preservationist tradition.

Callicott (2014) views the integrity of the wilderness as the source of Leopold's holism and land ethic, and his very practically employed anthropocentric arguments—like those in the Bible—toward a "non-anthropocentric anthropocentrism" (p. 176). (This is in the spirit of Bookchin's view that we can only be anthropocentric.) It is better stated as the unifying of ecological, evolutionary and social sciences with the evolution of anthropocentric ethics. These ethics dictate stewardship of God's non-anthropocentric creation, which it has yet to fully understand.

Ethical Evolution

Although Leopold may have begun with an environmental philosophy more in line with the utilitarian cost accounting inspired in Pinchot (see Chapter 2) and geared toward "equilibrium,"—or as Clements purported, a "climax state"²⁸—as time went on, he saw economics in his era as inadequate to fuel viable environmental reform (Goodwin, 2008). Leopold often mentioned the myopia and arrogance of our economic system, suggesting that private and public landholders would not uphold land health at the sacrifice of short-term profits (Meine, 1988):

²⁸ Climax states later became better described as a fluctuating steady-state (Odum & Barrett, 2005) often moving to new regimes with different elements and attributes than that of the previous ecosystem (Holling, 1973).

Thus far we have considered the problem of conservation of land purely as an economic issue. A false front of exclusively economic determinism is so habitual to Americans in discussing public questions that one must speak in the language of compound interest to get a hearing. (Leopold, Callicott & Flader, 1923/1991, p. 94; Meine, 1988, p. 188)

With the establishment and institutionalization of natural history museums and exploration of America's western territories, America became known as a leader in ecological studies (Kingsland, 2005). In reality, however, the practices of Western development drove the field of ecology (Kingsland, 2005). Kingsland (2005) concurs with Worster (1977; 1985) that America's rise to world leadership in the field of ecology enabled the field itself to develop, but she adds that it also led to massive exploitation of the land. Leopold recognized this exploitation early on.

Leopold begins his famous essay, "The Land Ethic," by explaining how slave girls were considered property and hung in the story of Odysseus. Since then, we have come to abhor such clear violations of human rights. Leopold argues that a similar ethical evolution may be "described in ecological as well as in philosophical terms" (p. 202), extending to the rights of the land itself,

Politics and economics are advanced symbioses in which the original free-for-all competition has been replaced in part by co-operative mechanisms with ethical content Yet there is as yet no ethic dealing with man's relation to land and to the 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 not obligations. (p. 201)

According to Curt Meine (1988), the leading national authority on Aldo Leopold, "the word 'land' itself says a lot. Leopold probably picked it because it was something

simple to understand and something bipartisan that everyone could get behind” (Meine, personal communication, 2014). In the abstract of the article, “The Conservation Ethic,” Leopold (1933) writes:

If our present evolutionary impetus is an upward one, it is ecologically probable that ethics will eventually be extended to land. The present conservation movement may constitute the beginnings of such an extension. If and when it takes place, it may radically modify what now appear as insuperable economic obstacles to better land-use. (p. 634)

Leopold finally roots the relationship between humans and the environment in a long-term sustainability ethic in the now famous essay, “Thinking like a Mountain,” (1949)(Clark, 2012), where only geological time has the wisdom to see the scale of the long-term and the damage caused by removing parts of the whole ecosystem. Leopold captures his principles on ecology, economics, science, and ethics in one stroke when he said, “the truth is that which prevails in the long run” (Leopold, 1923, p. 96). He applies this concept throughout *A Sand County Almanac*, proposing an answer to the complex SES problems caused by “progress” and “the economist” as a change in worldview and the adoption of a new ethical stance of stewardship (Leopold, 1949; Clark, 2012, p. 82).

Interdependency: Discussion and Conclusion

This chapter has placed Leopold within the context of ecological and sustainability issues of their eras through a coupled-systems worldview by being rooted in science and ethics for both the benefit of nature and society. Contemporary ecologists such as William Rudy evoke the *New Testament*’s references to “responsibility” toward the land, which included a deep, inherent sense of responsibility in the governorship of the Earth. He specifically evoked the Bible passage “let nothing be wasted” (*Bible*, 2002, John 6:12). Instead of being polarizing, Rudy sees religion as a uniting force, “spiritual

ideas can be less complicated . . . Mormons believe that everything is living.” For instance, a “traditional Mormon village was one of communal practices,” Rudy (2014) said.

Historian Donald Worster (1985), on the contrary, paints a picture of exploitation from these same practices, relating their ideas back to ancient ideas of building a “hydrological empire” (p. 24). Ideals of dominion (i.e., sovereignty, control) (Oxford, 2013), providential thinking, hierarchical thinking, and theories of continuous economic growth go hand-in hand in a Linnaean framework of nature (Worster, 1994a, p. 24). This thinking helped legitimize the “new factory society” and colonialism’s destruction of cultures and extinction of ecosystems in the formation of the Americas (Worster, 1994a, p. 53). In addition, it presented obstacles as it promoted the strict Christian eighteenth-century view of the Earth as a “well-oiled machine” (Worster, 1994a, p. 39).

Rather than provide an accurate model of the extremely “bewildering growth of biology” (Wilson, 2006, p. 13), such dogma has produced a reductive oversimplification of ecological systems to one of supply, encouraging an alarming ignorance toward our position in the universe, obscuring the necessary stewardship of the Earth and understanding of human-nature interdependencies. Leopold’s linking of science and ethics for long-term ecological and societal sustainability reversed persistent Platonic and Linnaean worldviews that still persist, and present obstacles for more ecologically-minded perspectives.

Foucault (1973) writes of Linnaeus that, “he opposed historical knowledge of the visible to philosophical knowledge of the invisible” (p. 138). Furthermore, in accordance with the influence of Plato’s forms and idealism, the cultural theorist Foucault (1973) has also argued that the “limit of knowledge” is precisely the limit of language (p. 20), making it problematic that ecosystems—more often than not— are described as “natural

resources” and “natural capital.” Systems naturalists, like Foucault, have also presented new understandings of old problems for an alternative sustainability discourse paradigm. It is one founded on the interconnectedness of human and natural systems, or one coupled system, which can enhance, advance, and clarify sustainability thinking.

White (1967) argued that the Bible “has inherent tendencies toward environmental exploitation” (Minteer, 2011, p. 40). Yet, a generation before, Leopold employed the values of the Bible to help counter ideologies of dominance and arrogance.. Leopold attacked typical exceptionalism and conservation ideals, which he saw as securely fastened to the value of continuous economic growth. He often framed our evolutionary trend and notions of progress as most often counter to an ethical obligation to protect the land, departing from conservation views during his time that were supposedly being accomplished through the USFS and concepts of sustained yield.

Many sustainability scholars commented that sustainability must be about “place” (Beatley, Byck, Klein, Meine, Rudy, personal communication, 2014). “If it’s not local, than it’s not sustainable,” said Meine (2014). Rudy stressed throughout the course of the interview that naturalists had an inherent practicality toward our relationship with nature. He elucidated that those who did not understand ecology, quoting Scott Russell Sanders, make the mistake of “rooting themselves in *ideas* rather than *places*”²⁹ (Rudy, personal communication, 2014).

The *steward* and *citizen-scientist* concepts seemed to be among the most practical naturalist applications outside of the university upon which almost all sustainability scholars could agree. “Today’s sustainability thinking is too complex. We need to go back to the ideas of conservation and stewardship” (Rudy, personal

²⁹ Rudy is referring to Sanders’ (1994) book *Staying Put: Making a Home in a Restless World*, and his response to Salman Rushdies’ comment that disenfranchised people of the Global South should root themselves in ideas, not places.

communication, 2014). Each of these words conveys older concepts that have gained currency in recent years, and not just in America. Ecologist and sustainability scholar Amber Bill for instance suggested (without any prompting) that the American concept of sustainability needs a “citizen scientist” program like the one in New Zealand (Bill, personal communication, 2014).

In Chapters 5 and 6, I have demonstrated how Thoreau understood the interconnectedness of human beings and nature and grounded his philosophy in the natural sciences. Leopold’s philosophy recognized the human and natural interdependencies for the betterment of both. Holistic concepts of interconnectedness and unification can help solve ongoing sustainability conflicts between economic and environmental positions and alleviate polarization between anthropocentric and non-anthropocentric value systems.

I explore how this might be accomplished in the next two chapters devoted to designing economic practices within environmental limits. As Rachel Carson and Edward O. Wilson reveal, the biggest casualty of the philosophy and practice of continuous economic growth and global expansion has been the natural diversity of ecosystems.

CHAPTER 7: ABSORBING ENVIRONMENTAL EXTERNALITIES (PRINCIPLE #3)

A recent report from the International Programme on the State of the Ocean (2015) said *all* ocean life is endangered, and if we continue along our same trajectory, they may well be extinct by the year 2050. Overfishing, run-off pesticides and herbicides, climate change, and other factors have conspired to damage oceanic species richness and genetic diversity as well as the biological services the ocean provides. These include nutrient cycling, cleaning the air and the water of pollutants, providing oxygen and eliminating carbon dioxide (CO₂), and other functions, developed over billions of years, which keep the planet inhabitable.

As Wilson (2002) writes, “Half the species of plants and animals on Earth could be either gone or at least fated for early extinction by the end of the century. A full quarter will drop to this level during the next half century as a result of climate change alone” (Wilson, 2006, p. 5). Human impacts have caused climate change, biodiversity loss, rising consumption rates, and other socio-ecological (SES) problems that produce cascading effects to social systems as well. However, these current challenges are often ignored on various local-to-global scales within today’s business, governmental, and industry decision-making processes.

A repeated theme of this dissertation is that viable solutions to SES problems will require mastery of not only ecology but also many of the sciences, social sciences, and humanities (Kates & Parris, 2003; Wilson, 1998; 2014). In many cases, however, these have been ignored in favor of sustainability theories based in economic growth, or watered down in an effort to balance environmental initiatives with socio-economic goals (Sarewitz, 2005). This makes current sustainability thinking not only ethically inadequate for the twenty-first century (as the last chapter discussed) but also

inadequate to the task of addressing the magnitude of SES problems in practice, the focus of this chapter's discussion.

Sustainability practices on the international level often do not recognize the true value of ecological loss. For instance, the Organisation for Economic Co-operation and Development³⁰ (OECD) defines *environmental externalities* as “the economic concept of uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost outside the market mechanism” (OECD, 2003, p. 1). This definition is not only completely instrumental, it neglects ecological and societal health outside this quarter's economic balance sheet.

In contrast, population ecologists William Rees and Meidad Kissinger (2010) describe *ecological externality* as “accelerating ecosystems degradation . . . associated with over-exploitation as global market forces increasingly assert their influence” (p. 2616). This description is much more to the purpose of SES problems, and it more precisely captures what systems naturalists view as threats to local-to-global ecological sustainability and ecological costs as centered on “global market forces” (Rees & Kissinger, 2010, p. 2616).

As discussed in Chapter 2, Rees has estimated the current overshoot of environmental resources and our ecological footprint at 1.5 planets (i.e., 50% over the carrying capacity) of the Earth (WWF, 2014). Yet, this has not prevented economic growth-based frameworks aimed at increasing production and consumption for more and more people from dominating not only sustainability thinking but also sustainability practices (Adams, 2006; Costanza, 1997; DuPisani, 2006; Jamieson, 1998; Kates, Parris & Leiserowitz, 2003; Solow, 1993; Svara, 2010). Thus, even on what has proven to be the most successful level of sustainability planning—the local level—initiatives frequently

³⁰ Since the early post-WWII era, the OECD has worked to stimulate the economy for “world trade” but primarily among Western countries.

center on a common set of “low-hanging fruit” endeavors (such as recycling, municipal operations, green buildings) and have been foregrounded in efficiency-measures and proven economic paybacks (McDonough & Braungart, 2006; Owen, 2012; Svava, 2010). While such practices certainly can contribute to sustainability planning, they cannot be considered the center of an overarching strategic sustainability discourse aimed at solving SES problems, given their scale and inherent complexities.

So, how can the holism of systems naturalists, particularly regarding the need to respect ecological limits within an integrated ecological and economic worldview, inform sustainability thinking? Furthermore, why is this perspective critical for rethinking sustainability practices? Many sustainability thinkers (Brown, 2011; Brown, Harris, & Russell, 2013; McKibben, 2006; Wilson, 2002) have argued that what is needed is a transformational accounting system that would pay for environmental stewardship; preserve vital, life-sustaining nature (Owen, 2012); and ground the theory of sustainability practice in real, long-term human-nature relationships not exclusively bounded to economic principles based on short-term gains.

The next two chapters examine a ubiquitous commitment among the four naturalists in this dissertation—the critique of the impacts caused by economic growth and practices based on everlasting expansion of markets (Worster, 1994a), starting with the naturalist theoretical views on the relationship between ecology and economics. The organization of this chapter begins, as in the last chapter, with current sustainability practices and the challenges and limitations the present followed by a description of historical economic problems that will continue to plague the theory of sustainability practices if left unchecked. Environmental externalities, and the belief that the market will eventually correct for expected outcomes via the setting of correct prices, is a historical and ongoing problem.

Next, I cite examples of how systems naturalists' principles prevail over these inherited problems. Many of these principles are as applicable today as they were then. In opposition to many current business-as-usual practices, I demonstrate that systems naturalist principles inherently linked the fields of ecology and economy, and provide the structure and complexity commensurate with what is needed to solve SES problems today. Their principles necessitate a worldview for sustainability that demands, among other things, a transformation of the economic system that entails balancing economics with science and ethics. But before going into the solutions, we need to first examine the historical and ongoing problems of environmental externalities and efficiency-based sustainability practices in more detail.

The Problem of Environmental Externalities

This discussion will briefly describe the course of the development and depletion of resources in the 1800s in the United States and the creation of massive environmental externalities.³¹ Historians, such as Frederick Jackson Turner (1894) who elaborated on it in newspapers, books, and journals during the 1890s, have often interpreted “taming the American West” as one of our defining characteristic. Indeed, in America we have often defined ourselves by our rugged individualism and the fierce competitiveness that emerged from a pioneer spirit whose mission it was to tame the savage land (Nash, 1973; Turner, 1894). Military metaphors, such as “conquer,” “subdue” and “enemy,” were commonly used to describe land-clearing techniques (Nash, 1973, p. 27). However,

³¹ Economic externalities were first formulated by the English welfare economist Arthur Pigou (1877-1959), which could be captured, as Costanza (1997) and Daly and Farley (2004) propose, with special taxes (De Steiguer, 1995). But environmental externalities also have deep roots. For instance, the Battle of Salamis “catapulted Athens into the role of Eastern Mediterranean superpower” (Solomon, 2011, p.70) but also sowed the seeds for its fall. Rapid economic expansion usually leads to environmental externalities (Panayotou, 2003). Thus, Athens’ overly rapid economic growth coupled with hand-in-hand with conquest may have also led to collapse (Mumford, 1961). After the Peloponnesian Wars (431-404 BC), Athens’ system of conquest and slavery—the economy’s main source of energy—crumbled, along with their domination of Mediterranean trade routes (Kotkin, 2008).

historical scholarship over the last twenty years has shown the stark reality of this ideal, highlighting that many once bountiful natural resources have been damaged or depleted beyond immediate repair.

European settlers arriving in the Americas viewed the immense tracts of wilderness with both “awe and fear,” and “utility and exploitation” (Worster, 1992, p. 14). They also interpreted it as the “antithesis” of civilization (Cronon, 1992, p. 28). Wild predators and “varmints,” for example, as well as bothersome “ungulates” were viewed as “discommodities” (Cronon, 1992, p. 28). When dangerous, as bears and wolves were considered to be, significant bounties of \$5-10 were placed on their heads and their numbers were quickly decimated (Cronon, 1992). We know today that such practices can cause wildfires, alter the course of rivers, and exact an enormous toll on ecosystems diversity of plant and animal species by annihilating its keystone members.³²

Throughout America, Indian agricultural “slash and burn” and crop rotation methods that restored important nutrients to the soil (i.e., rotation of burning forest to add nutrients to the soil, and allowing land to lie fallow) were quickly eliminated before their value could be understood (Cronon, 2003). While some, like Thomas Jefferson, held an “alternative” view of nature, an ethical vision of biodiversity and local watershed-based communities, the 1800s pioneers decimated the “inexhaustible prairies,” the forests along the Great Lakes, and the fisheries of the Northeast (Meine, 2004, p. 16).

Worster describes Massachusetts in 1700 as a “dark, primeval jungle” where trees “six feet in diameter” towered at “250 feet in height,” but after only a century almost no first-growth forests remained (p. 67). Thoreau studied the “vanishing forest milieu,” and attacked Puritan forefathers for not preserving the “primitive,” or first-growth, forests of

³² Keystone species, often large mammals and predators, have a critical role in maintaining ecosystems. If keystone species are extirpated, an ecosystem is likely to shift into a new regime, sometimes where the old regime can be hardly recognized (Holling, 1973). Wilson (2015) argues even good biologists and ecologists have made mistakes of which species in an ecosystem are keystone species.

New England (Worster, 1994, p. 70). Seeing this, Thoreau was “able to refute many of the prevailing explanations that relied upon faith or tenuous conjecture” (Howe, 2009, p. 398). “This contrasts with previous understandings of the natural world, which often made reference to mystical or metaphysical considerations to account for natural phenomena” (Howe, 2009, p. 398).

Moreover with “no effective forestry in the United States” until Gifford Pinchot’s era in the 1890s (Meine, 2004, p. 18), forest areas, which by today’s value might be in the billions of dollars, were among the first environmental externalities, as pioneers gobbled up everything but hard to reach and non-arable mountainous regions. The US government bestowed 160 acres to pioneer farmers in the original Homestead Act (1862) that transformed the land, destroying many endemic species of plants, and animals and eroding the soil. Ranching practices also resulted in soil degradation and loss of nutrient-rich topsoil. It also disturbed rivers whose flow was already greatly diminished due to expanding settlements. While not all pioneers saw the natural world as an enemy, pioneers may have simply “lived too close to nature to appreciate it” (Nash, 1973, p. 31).

In the Northwest dams were installed as holding points for thousands of logs that were then flushed downstream in intentional floods toward a lumber mill and devastated stream ecosystems and the salmon and fishing industry (Lichatowich, 1999). Fish biologist James Lichatowich (1999) explains in *Salmon Without Rivers: A History Of The Pacific Salmon Crisis* how the fur trade, dredging for gold, and the building of dams destroyed the ecosystems of the great Northwest rivers, especially the salmon who used these as spawning and migration paths. Lichatowich (1999) writes of the splash dams and other factors that caused the collapse of the salmon:

Today after a century of human failure to seek balance between the natural and industrial economies, the Coho and Chinook salmon and steelhead are on the

verge of extinction In the meantime, the Lords of Yesterday are using . . . the same arguments they used a half century ago to continue to use splash dams. (p. 66)

So in forest, soil, riverine ecosystems, the environmental externalities were not even considered, leaving a clear legacy of irresponsibility for today. The next section, which comprises the bulk of this chapter, is devoted to how systems naturalists approach environmental externalities and efficiency.

Carson and Wilson: Bounding Economies with Ecology

We can extrapolate American exceptionalism and its consequences well into the second half of the twentieth century, where these inherited values and resources began to first come up against national shortages, and water and fuel rationing during the Carter Administration. Scarcer ecological resources, large inequalities,³³ failed states, abysmal school systems, and climate change are among the SES problems that have led McKibben (2006) to write, in the vein of Thoreau's *Walden*, "growth simply isn't enriching most of us" (p. 14). Indeed, Thoreau often railed against the economics of his time, which, because of its extremely loose system of the free market, had created "such an unwieldy and overgrown establishment, cluttered by furniture and tripped up by its own traps, ruined by luxury and heedless expense . . . the only cure for it as for them is in a rigid economy" (p. 89).

In Chapters 5 and 6, I employed systems naturalists such as Thoreau and Leopold to describe how pro-economic growth measures very often lead to economic externalities and eradicate important life-, health-, and wealth-sustaining ecosystems as well as ignore the wealth of ecosystems knowledge. These concerns lend to their work an

³³ Although the American economy, for example, has demonstrated continued growth from 1979 to 2005, the average real dollars earned by American workers fell approximately \$1,500 annually during that time (McKibben, 2006, p. 9-10). A more recent report (Oxfam, 2014) indicates the number of billionaires has doubled since the recent economic crash.

important cultural currency in today's discussions about a sustainable economic order. For example, Thoreau's frustration with the "structure of the economy that requires us to approach nature as nothing more than raw materials to be exploited in the productive processes" clearly resonates today (Taylor, 1996, p. 83). Leopold (1949) encouraged us to "quit thinking about decent land use as solely an economic problem" (p. 246).

In this discussion, I examine how Rachel Carson and E. O. Wilson argue for a platform of political and economic transformation centered on restoration and preservation policies, the use of scientific and ethical principles for the internalization of environmental externalities, and reducing impact as the basis for a sustainable economics in the twenty-first century.

Today, the American entrepreneurial spirit is echoed in economic markets at home and abroad through the ideologies of democracy, the free market, and globalism. Unfettered by environmental regulations and incentives, the practices of these ideologies will continue to exploit the remaining valuable ecosystems. Carson (1962) and Wilson (1998; 2002) have devoted large portions of their writings to the description of ecosystems and genetic variation. They understand the multitude of interactions that occur in ecosystems. Further, they have also realized that in order to change business-as-usual practices, we cannot only look at ecosystem health and wellbeing, but we must also focus on human health and wellbeing. Moreover, by solving for ecological wellbeing, we will solve for societal, and by default, economic wellbeing.

The Social and Environmental Costs of Industry

Carson's writing career began somewhat like Thoreau's. She wrote expressive biological inventories that went beyond the basic parameters of such an assignment. With her notably powerful and articulate prose—and often becoming so philosophical (departing from strictly scientific writing) —she began submitting her work to literary

journals and book publishers. Her treatises, which depicted and interpreted the interdependence of both marine and land life focused on multi-generational environmental issues, problems, and risks to human and ecosystem health, are fundamental and crucial to advancing sustainability today (Lytle, 2007). But also, as I argue here, she exposed many of the significant environmental costs (i.e., externalities) of our system that negatively affected and threatened the air, land, and sea of the planet.

By the late 1950s, Carson had written two detailed naturalist accounts of ocean life in *The Sea Around Us* (1951), and *The Edge of the Sea* (1955), which articulated a non-anthropocentric viewpoint from various creatures at the meeting place of land and sea, and highlighted the constant change and flux of ecosystems. By this time, she had also read a worrisome number of reports of widespread pesticide spraying destroying entire ecosystems. Had the environment around her not been imperiled, Carson would have probably gone on to write a book about evolution (Lytle, 2008). Instead, she applied of her considerable abilities and energies into a book called “*Man Against Nature*,” which was later renamed *Silent Spring*.

By the late 1960s, Carson’s almost 35 years of experience as a writer, government worker, field biologist—and naturalist—made her privy to what was then popularly unknown information on the health of ecosystems, as well as making her an authority on a spectrum of scientific views. Her eloquence as a writer qualified her to be an authority to write about the health and condition of the natural world as being threatened by the onslaught of a seemingly unending stream of new chemicals on a national level.

Near the end of her career, Carson (1962) suddenly shifted gears from her vivid, National Book Award-winning prose in the tradition of naturalist Henry Beston³⁴ (1888-1968) to focus on the studies of public health, the chemistry of herbicides and pesticides,

³⁴ Henry Beston (1923) in the tradition of a systems naturalist, wrote, “Poetry is as necessary to comprehension as science. It is as impossible to live without reverence as it is without joy” (p. 217)

and bioaccumulation to reveal the human and environmental costs caused by our industrial lifestyles, down to how people cleaned their homes and took care of their lawns. Carson notes in *Silent Spring* (1962) that there were over “500 new chemicals to which the bodies of men and animals are required to adapt each year,” (p. 7). This number may seem low to us now, but was considered deplorable during this time of almost non-existent monitoring and reporting.

She did not see the problem as originating in science—the breakthroughs of which she often reveled in—instead finding fault in schemes of unregulated industrial practices: federal, state, and local governments, and fast economic growth that did not examine the long- or short-term consequences. Although the validity of her research was initially questioned, Carson would be later vindicated by economic costs associated with cleaning up from chemical contamination. For example, just the subsequent Love Canal and Cuyahoga River cleanups were estimated in the hundreds of millions of dollars. But, it was the values that could not be fully calculated, the losses to human and ecosystem health that would have the greatest impacts (Lear, 1998).

As Carson noted in *Silent Spring* (1962), hers was an “era dominated by industry, in which the right to make a dollar at whatever cost is seldom challenged” (p. 13). The “cost” to which Carson (1962) referred can be called environmental externalities. These externalities included the toxic pollution of land, sea, riverine, and air ecosystems that were the very real byproducts of economic progress (Rees and Wackernagel, 1996). She stressed that there were more than a few costs associated with the US being the “bread basket” of the world in the post-WWII era. These costs included the impacts of the extensive use of toxic pesticides, which enabled the massive agricultural production. This national agricultural activity, in addition to producing an abundance of grain, also globally distributed toxic and ecologically destructive chemicals. Further, it had

enormous environmental externalities such as devastation of wildlife habitat, loss of species, mutated fetuses, and the poisoning of drinking water (Carson, 1962).

Carson's approach was novel, marking a break from some of the earlier naturalist-conservationist writers. She more specifically aimed her focus and analysis at industrial practices in the United States that capitalized on ecological externalities. Hence, she established fundamental concerns and a well-articulated framework that should be considered when evaluating sustainability theory. She initiated what would become known as a new sphere of "environmentalism" in the late 1960s and early 1970s (Shaeffer, 1991). She revealed that industrial practices, such as the application of DDT, resulted in an array of negative externalities such as poisoning groundwater, crops, and soils that made its way into animals and humans, more often than not underscoring important scientific and philosophical points with real economic costs.

Carson (1962) showed Americans for the first time that such economic externalities—externalities likely equal to the size of the economy itself (Costanza, 1997)—were the result of rapid economic growth without oversight or attention to ecological impacts. In describing the brush spraying in Maine she writes:

Once it had been a joy to follow those roads through the evergreen forests, roads lined with bayberry and sweet fern, alder and huckleberry. Now it was brown desolation. One of the conservationists wrote of that August pilgrimage to a Maine island: "I returned . . . angry at the desecration of the Maine roadsides. Where in previous years, the highways were bordered with wildflowers and attractive shrubs, there were only the scars of dead vegetation for mile after mile . . . As an economic proposition, can Maine afford the loss of tourist goodwill that such sights induce? (Carson, 1962, p. 70).

Feminist and environmental ethicist Vera Norwood (1987) has described the political and economic views of industrial economics during the post-WWII era as one in which neither the organic nor human household definitions of *eco*—the root to ecology and economics—are respected. Carson protests seeing species consistently and solely being framed in terms of “food chains” and “categorized as producers, consumers, reducers, and decomposers” (Norwood, 1987, p. 746).

Carson appealed to Americans by describing the costs in terms of dollars on many occasions in *Silent Spring*. As early as 1962, American taxpayers were paying more than a billion dollars a year to “pay farmers *not* to produce” (p. 9). During the mass use of DDT by the Department of Agriculture in the 1950s and 1960s, many ecosystems were disturbed beyond repair, illustrating the entropy, or irreversibility, of converting “natural capital” or real resources to dollars. But, she also goes deeply into the incalculable expense of losing our cultural and pastoral roots, “Roadside sprays, they may have cost the farmer his cow and killed uncounted numbers of wild creatures” (p. 35). Carson argues further:

Were the true costs entered not only in dollars but in many equally valid debits . . . the wholesale broadcasting of chemicals would be seen to be more costly in dollars as well as infinitely damaging to the long-range health of the landscape and to all the varied interests that depend on it. (p. 69)

“Yet is the real problem not one of overproduction?” she asked (1962, p. 9). Carson’s rhetoric built upon thinkers like Leopold, by noting that institutions like industrialized agriculture were a threat to future sustainability. But instead of confining her approach to highlighting how the private farmer could contribute, she demonstrated to the public at large the direct costs to their own health, and the ecological integrity they had previously taken for granted. With industries reaping all the benefits and paying

none of the costs, Carson was one of the first to point out that common industrial practices—which fueling unprecedented economic wealth—violated what today is called the precautionary principle, which states that when there is suspected risk, the burden of proof of environmental safety is on the producer. Carson went much further than Leopold and almost all of her contemporaries by clearly illustrating the multifaceted consequences regarding human health on a global level, and community level, and even to the genetic level. As old and new chemical-laden, industry-driven by-products continually surged into land, rivers, seas, and the air, no efforts were made to calculate their inherent, diverse, and wide-reaching environmental risks, “until the process has become embedded in a vast economic and political commitment, and then it is virtually impossible to alter it” (Carson & Lear, 1963/1998, p. 232).

Scientists in the Economy

One outcome of Carson’s work was the raising of the level of concern for global ecological integrity. But going further still than Carson is Edward Osbourne Wilson (1929-). Wilson began by exposing the same general industrial shortcomings but elaborated in depth the solutions to preserving biodiversity—which for Wilson was the center of preserving human and ecological health and wellbeing alike.

In examining key problem areas like the over-harvesting of fisheries, Wilson tackles issues only beginning to come to light in the 1960s and 1970s. The fishing industry dishes out 20 billion dollars in annual subsidies to fisherman, Wilson (2002) notes, “[I]n the year 2000 alone the advantage to consumers is outweighed by the cost to fishery stocks. The subsidies are one reason that all of the key ocean fisheries are now below sustainable levels” (p. 183). While many economic schemes to price the economy have failed, Wilson argues that if contemporary scientific, socio-ecological, and ethical

principles played a part in the economy, the planet could be preserved for people, plants, and animals.

Most ecological scientists have not endorsed trading off between economic and environmental values. For example in Gloucester, MA, subsidies for fishermen that have saved jobs in the short term have done more harm than good in the long run. In the once thriving fishing community of Gloucester, despite millions of dollars in government subsidies, fishery managers found it necessary to enact the “most drastic catch limits ever seen in the history of New England fishing, slashing the amount of cod that may be caught in the Gulf of Maine by 77 percent” in May of 2013 (Russell, 2013). Thus preserving jobs for the short-term did not result in long-term health and wellbeing for either the society or the ecosystem in which it was embedded. Since 2001, the number of fishing vessels that could survive in the exhausted fisheries diminished from over a 1,000 to a little over 300 in order to restore fish populations, only to find in 2011 that stocks were not repopulating, and the system is beyond repair (Russell, 2013).

Enormously prolific, Wilson has authored hundreds of articles and over 25 monographs covering an impressive breadth of topics from evolutionary theory and genetics to his 300-year history of the sciences and humanities. He examines the role of disciplines such as economics, ecology, genealogy, and many more as they arrive upon the academic scene. Interestingly, Wilson’s own writing has systematically avoided the rhetoric of sustainability. Wilson, who began his studies of biology during Carson’s era, made breakthroughs in ecology early in his career at Harvard University where he worked to “bring population and community ecology closer to genetics” (Wilson, 2006, p. 239). His theory of island biogeography still has important applications to urban fragmentation. Unbeknownst to many who think of Wilson as largely a biologist, he has thoroughly examined the human-social relationship in his recent work –*The Social*

Conquest of the Earth (2013). His work is taking ecology in an original direction, helping to form the foundation of transdisciplinary studies of socio-biology (1985), biodiversity (1986), conservation biology, and biophilia (1986).

Likewise, Wilson has argued for strict global restoration and preservation initiatives, to include:

- “Ceas[ing] all logging in old growth forests everywhere”
- Restoring and preserving all “biodiversity hotspots (reservoirs of biodiversity)”
- Increasing global protected areas from 10% to 50%
- “[S]upport[ing] population planning” (p. 161-5)

Wilson (1998; 2002) has been very outspoken in arguing for raising the standard of living, which he feels is essential to the protection of ecosystems. He states,

In essence, the answer I will now pose is guardedly optimistic. In essence, it is that the problem is now well understood, we have a grip on its dimensions and magnitude, and a workable strategy has begun to take shape. The new strategy to save the world’s flora and fauna begins, as in all human affairs, with ethics. Moral reasoning is not a cultural artifact invented for convenience. It is and has always been the vital glue of society, the means by which transactions are made and honored to ensure survival. (p. 151)

Most notably, Wilson (2002) sets up the age-old, non-anthropocentric-vs. - anthropocentric polarity that is another dichotomy similar to previously mentioned (e.g., Worster’s Arcadian vs. Imperialist, and Norton’s preservationist vs. conservationist) as “environmentalist vs. economist” in the *Future of Life* (2002). Although he ultimately chooses the environmentalist over the economist, and over integration of the two views,

he argues that countries must rely on “natural resource specialists” or “ecological economists” (2002).

A country that levels its forests, drains its aquifers and washes its topsoil downriver without measuring the cost is a country traveling blind. It faces a shaky economic future. It suffers from the same delusion as the whaling industry. As harvesting and processing techniques were improved, the annual catch of whales rose, and the industry flourished. But the whale populations declined in equal measure until they were depleted . . . Extend that argument to falling ground water, drying rivers, and shrinking per-capita arable land, and you get the picture. (p. 26)

Wilson’s polemic is not limited to the United States or Western countries. He draws on a score of international examples, like China, where the cost of agriculture is rising as water resources are being depleted to meet the rising middle class’ demand for more food.

Environmental benefits are often not calculated until a significant problem presents itself, such as in New Orleans, New Jersey and Texas when hurricanes Katrina, Sandy, and Ike damaged coastlines at costs in the tens of billions of dollars. Wilson (1998) argues, “Even if adequate scientific knowledge [of ecology] were available, there would still be little basis for the long-term valuation of forests. The economics of sustainability yield is still a primitive art . . .” (p. 11). He also argues that we cannot continue to use *any* resources beyond a genuine sustainable yield—which has not yet been calculated (2002). In *Consilience* (1998), Wilson writes that economics formerly had many more direct and tangible relationships with the environment.

Balance Ecological and Technological Sciences

Carson devoted a good portion of her life to understanding the intricacies of ecosystems; however, in 1957, she began educating herself on something outside of her field: American industrial practices. In general, she viewed industry as declaring a “war” on nature. She saw technology’s failure to control nature through unnatural, even violent changes rather than applying science to work within the boundary of what was safe. Like Leopold (1949), her work (1962) proved that many of our practices, especially the eradication of certain species, was pathological, idiotic, and extremely short sighted.

In *Silent Spring*, she showed how the mass spraying of pesticides for eliminating insects often had the unintended consequence of actually making them resilient. She discussed how undisrupted ecological systems were “biologically sound” when birds, spiders, ants, and owls controlled parasitic insects (p. 295). With the introduction and unrestrained use of pesticides, many of these natural predators were killed off as an unintended consequence. Population explosions among unwanted pests wiped out the species’ competitors (Carson, 1962, p. 257). She argued that industry needed to stop such business-as-usual practices that so drastically altered ecosystems and to get off “the treadmill of chemical control” (p. 279).

Thirty years later, Wilson (1992), a myrmecologist by nature, provided a telling example in his afterword to *Silent Spring*, “Just one surviving colony [of the red fire ant, *Solenopsis invicta*] missed by the poison sprays is enough to reseed an area of many square miles. When the new formal scientific name for the species was being decided . . . the logical name was *invicta*, meaning ‘unconquered’” (p. 360). Wilson (1992) goes on to describe the post-World War I era as the “Vietnam of Entomology,” the assault on the fire ant—that in turn poisoned livestock, birds, and riverine populations—resulted in a far-flung web of contamination that extended its deadly, poisonous reach all the way to the arctic poles (p. 360). “It will take millions of years to correct the loss of genetic and

species diversity by the destruction of natural habitats,” Wilson writes. “This is a folly our descendants are least likely to forgive us” (Wilson, 2006, p. 355).

But neither Carson nor Wilson has proved to be against all kinds of technologies, only technologies applied in such a way that they violate the ethic of preserving biodiversity. They both look to elements of biophilia and biological technologies, or biomimicry, as not only solutions for saving ecosystems and aiding human development, but also as economically valuable. For instance, in *Silent Spring*, Carson discusses the use of biological controls in large scale such as in California with the Vedalia beetle, or Lady beetles (Ladybugs) (p. 256). These controls are available at a much lower cost (p. 257) than chemicals whose costs, both in terms of money and impacts, continue to rise.

Wilson (1984) developed the biophilia hypothesis to explain the “innate tendency to focus on life and lifelike processes” (p. 1). The hypothesis has been tested among everything from cancer patients and Goldman Sachs employees, and findings have shown that people need direct contact with nature to be happy and healthy. This can have direct economic benefits by making workers have fewer missed days, be more punctual, and become overall more productive workers (Kellert, personal communication, 2014; Kellert & Wilson, 1993). Wilson’s work and related studies have confirmed what Romantics and Transcendentalists have always known (and without the benefit of research studies)—that to be healthy and happy, we need to interact physically with the natural world on a regular basis.

Biophilia contributes to an ethic of enlightened self-interest, an evolutionary-based argument for the human affiliation with nature. Both Carson’s and Wilson’s worldview, driven by planetary survival, can help frame sustainability in such a way as to counteract the “natural economy crumbling beneath our busy feet” (Kellert & Wilson, 1993; Wilson, 2002, p. xxiv).

Absorbing Externalities: Discussion and Conclusion

US expansion into previously pristine territories during the rise of industrialism through the nineteenth century can serve as a prime example of environmental externalities. During European colonization, settlers had all but extinguished Native American agricultural methods that restored important nutrients to the soil (e.g., burning and allowing land to lie fallow), depleting it for the long-term. Although the first population demographer Thomas Malthus' warned that exponential growth and expansion would lead to war, famine, and destruction (as it did for most species), colonialism spread the values of industrialism and efficiency around the world. In the US, pioneers devastated integrated forests, prairies, and riverine systems, homogenizing countless ecosystems—many to the point of depletion and ruination.

The sustainability paradigm, as it stands, recognizes tradeoffs in which ecosystem services are often traded for economic benefits, like jobs, and raising the standard of living and increasing the Gross National Product (GNP). This type of paradigm undervalues ecosystem services; and GNP has long been known not to be an especially good measure of the economy (Costanza and Daly, 2002; Norton, 2005). Yet, even when limited by a purely utilitarian understanding of sustainability, it only makes sense to preserve and restore ecosystems if for no other reason than just for the sake of humanity's future. Rachel Carson, however, provided a strong critique of industrial practices that can only be remedied by bringing ecological science into the foreground of decision-making. Wilson provides an in depth historical analysis of how to relate science and ethics for planetary survival.

Although most economists admit that environmental externalities continue to present the largest problems to our current and inherited neoclassical economic framework (Caradonna, 2014), ecological economist Herman Daly (2004) points out

economic decision makers often neglect them. Sustainability indicators, which specifically describe practical applications, have generally tended to emphasize economic rather than ecological or ethical interests (Adams, 2006; Costanza, 1997; DuPisani, 2006; Jamieson, 1993; Kates et. al., 2005; Solow, 1993; Svara, 2010). This bias has been attributed to a lack of agreed-upon indicators for these other values (Parris & Kates, 2003; Kates et. al., 2005) and the difficulty inherent in discussing normative values as metrics (Pijawka, 2015).

Where locally based indicators do exist, in most cases they are lacking in some way and “need not be linked to land, the land’s functioning, or to any ecological science” (Newton & Freyfogle, 2005, p. 23). This lack of joining land functionality and ecological science to locally based sustainability indicators constitutes a crucial mistake. This critical omission has led to the continuation of subsidies, which proven harmful to the environment and long-term economy, and efficiency-based policies, which devalue, undervalue, or ignore other factors. How can human sustainability *not* be grounded in ecological sustainability when we are approaching (or have surpassed as some would argue) the ecological carrying capacity of the planet? (Brown, 2011; Pijawka, 2015; Rees, 1992).

Gary Lynne (personal communication, 2014) suggested that the “transdisciplinary field of *ecological economics*” is the antidote that could abate ongoing environmental externalities. Lynne argues in favor of the development of behavioral economics, a science he admittedly did not grasp until after he had received his doctorate, having been schooled in the classical economics tradition. Stating very simply that today’s modern economic system “represents bits and pieces of reality, but not reality,” Lynn (personal communication, 2014) said he wished he had paid more attention to the behavioral economists in the beginning of his work, as that discipline

would ultimately guide recommendations for a sustainable economic system. Lynne wholly agreed economics has not been holistic. Naturalists, he said, tell us who we are, which possesses greater saliency and importance than identifying statistical and homogeneous human “trends.”

Most economists acknowledge enormous environmental externalities, yet little research is done there (Lynne, personal communication, 2014). The mainstream primarily considers ecosystems placed within the confines of the framework of human economics. Wilson (2002) sees environmental externalities today resulting in extremes both in poverty and affluence, especially in developing countries whose natural resources are being depleted rapidly, often before they can even be registered. Yet, Wilson (2002), echoing Thoreau’s critique of the unethical practices within capitalist and corporatist systems, finds hope in guiding the economy through the principles of science and ethics, and thereby using the concept of consilience to significantly reduce our ecological footprint.

In the next chapter, I will examine how Thoreau’s model of re-coupling ecological and economic systems must guide sustainability practices. In their writings, systems naturalists have universally criticized the economic domination of ecology, and I believe they are uniquely equipped to help us learn how to coordinate ecological sustainability and economic growth. In doing so, they follow in the venerable tradition of the systems naturalist Aristotle, who wrote that economics had a normative role and function in conforming to the needs and desires of society (Mumford, 1961). According to Aristotle, economics “must conform to nature . . . in as much as nature has distributed roles and duties within the species themselves” (Mondzain, 2005, p. 19). I suggest that the four systems naturalists of this dissertation can teach us how to accomplish Aristotle’s ancient challenge.

CHAPTER 8: ECONOMIC PRACTICES WITHIN ECOLOGICAL LIMITS (PRINCIPLE #4)

Industrial efficiency, the sustainability problem discussed in this chapter, is directly related to environmental externalities. Environmental externalities, particularly in terms of efficiency, have long been a part of the United States' growth. This is because efficiency policies have in fact historically increased national use and overall consumption of natural capital (Hallet, 2012; McDonough & Braungart, 2006; Owen, 2012). Models of efficiency are also frequently oblivious to the changes in the environment, such as future damage due to climate change (Costanza, 1997; Daly & Farley, 2004; Rees, 1996). As a consequence, there are enormous environmental externalities in the market (Costanza, 1997; Daly & Farley, 2004; Rees, 1996). Sustainability theorists—as well as concerned citizens, advocates, and scientists—often demand the recognition of and the correct valuation of ecosystem resources. But, locating such economic valuation schemes that are accurate and well-grounded have often proved elusive (Daly & Farley, 2004; Lynn, personal communication, 2014).

As set forth in the *Brundtland Report*, the contemporary sustainability framework aims to achieve a balance among three pillars—economics, environment, and social equity—for today and for future generations. But, in practice, the *Brundtland Report* has been characterized as primarily *efficiency-based* and its initiatives as incremental—rather than transformational—in substance (Grober, 2012; Hallet, 2012; Newton & Freyfogle, 2005; Owen, 2012). Jeremy Rifkin (2004), when speaking of Adam Smith, wrote that efficiency was “the ultimate tool for exploiting both the earth’s resources in order to advance the material wealth and human progress”—when applied to society in general (p. 384).

Efficiency-based growth and environmental externalities have largely led to the wealth we have today. For example, since the early 1800s, fossil-fuel energy has, in many

cases, replaced and multiplied the efforts of human manpower supplying us with a greatly increased energy and standard of living (Redman, 1999). Fordism and mass production techniques have inspired every area of production to achieve higher and higher levels of efficiency, and steadily rising wealth, measured by the increase in Gross National Product (GNP)(McKibben, 2006).

But, this accumulation of wealth has come at great cost, both socially and environmentally. From the inception of this unbridled growth, many costs (such as biodiversity loss and soil degradation) were not calculated but such costs allowed populations to grow to bloated proportions. With this growth, humans have now released trillions of tons of harmful greenhouse gases (GHGs) into our atmosphere, led to the depletion of finite resources, and forced climate change and biodiversity loss. As a result, industrialization and dwindling energy supplies now threaten both the stability of economies and ecosystems in countries around the world (UN Habitat, 2013).

Henry David Thoreau saw efficiency not only as endemic to the emerging economic system tied to factory and mass production during his lifetime but also as an impediment to moral progress, as necessities like food, fuel, shelter and clothing became not ends, but means to higher ends. As Thoreau scholar Bob Pepperman Taylor states in *America's Bachelor Uncle: Thoreau and the American Polity* (1996), "In the process of creating a fantastically wealthy society, we complicate our economy beyond our ability to control it" (p. 82). In *Walden: or Life in the Woods* (1854), Thoreau's main polemic is directed against his neighbors' handing over of their way of life to an economy that provides neither health nor wellbeing, to either human beings or nature. "Most of the luxuries, and many of the so-called comforts of life, are not only not indispensable, but positive hinderances [sic.] to the elevation of mankind," said Thoreau (Thoreau & Cramer, 2012/1854, p. 208)

As I will discuss next, in order to be effective, sustainability cannot be a continuation of the efficiency measures of the early industrial, progressive, and post-World War II (WWII) eras. Hawken, Lovins, and Lovins (2008), the authors of *Natural Capitalism: Creating the Next Industrial Revolution* acknowledge that annual ecosystem-service externalities are estimated at “36 trillion” (p. 155), but they assert that our energy supply does not need to grow, that all the energy we need can be found by increasing levels of efficiency. Three of the most prominent ecological economists, Robert Costanza (1997) and Daly and Farley (2004) argue this from a different perspective. They posit that sustainability is essentially about ecological limits and that we must rethink how our behavior effects ecosystem services all together. Next, after briefly discussing the problem of sustainability based on efficiency, I will discuss Henry David Thoreau’s ability to live within ecological limits and be efficient.

The Problem with Eco-Efficiency

Equating *efficiency-only* measures with sustainability, while willingly allowing for net ecological footprint increases, will not reduce net consumption. In New England in the 1800s, factories sprung up in former mill towns, making the shoes, clocks, and bricks that had once been hand crafted in small villages, and Americans increasingly abandoned their farms, moving to larger cities (Sullivan, 2009; Walls, 1995). Thoreau’s era (the first half of the nineteenth century) coincided with the first waves of industrialism in America, which decoupled the relationship between manpower and wealth. As America’s borders expanded west with new land purchases, the Mexican War, and a gold rush in California, farmers in New England began to migrate westward, and New England farmers could not compete with the more productive farms in the west. Such developments led naturalists like Thoreau to question the consequences of the new and materialistic factory and efficiency-based culture.

Ecological economist Robert Costanza (1997) embraces a hardline stance that economic growth like that of the Industrial Revolution, the Progressive Era, and the post-WWII era, is directly proportional to environmental destruction. Herman Daly (1989), also an ecological economist, rejects the idea that the “economy of nature has solely human and instrumental purposes” (Daly, 1995, p. 624). Daly & Farley (2004) acknowledge in their textbook *Ecological Economics: Principles and Applications*, the vital importance of environmental limits. “The 1997 ecological footprint of the earth’s total population was at least 30% more than the Earth’s biological productivity” (Daly & Farley, 2004, p. 35), a disproportion which leads us not to *increasing*, but to *decreasing* efficiency, a problem the systems naturalists, however, have steadily tried to bring to our attention for decades if not centuries.

“The problem is that economic growth is a given,” said sustainability scholar and educational consultant Susan Santone (personal communication, 2013), iterating some of the themes of this dissertation:

It’s very important to differentiate between development and growth. In the 1990s and 2000s, the size of homes increased tenfold due to the exurbs and increased urban sprawl. And tradeoffs for growth and jobs and what was considered progress have led to systemic problems that made the world very clearly much less sustainable.

The truth is that most efficiency measures (like those that emerged from the *Earth Summit*) lead to more production and consumption (McDonough & Braungart, 2006; Hallet, 2012; Owen, 2012). This phenomenon was first described in detail by the economist Stanley Jevons with *The Coal Question* (1865). The book advanced the premise that the more efficient coal engines being produced would increase demand and not help preserve England’s coal supply. Rather, it would help exhaust it. Jevons

predicted that this would happen in less than a hundred years. England did indeed exhaust all of its affordable coal reserves. How could this happen?

The way sustainability leader David Owen (2012) puts it, When we talk about increasing energy efficiency, what we're really talking about is increasing the productivity of energy. And, if you increase the productivity of anything, you have the effect of reducing its implicit price, because you get more return for the same money—which means the demand goes up. (p. 112)

As described in Chapter 2, the concept of maximum sustainable yield promoted by Pinchot would guide the formation of resource management in America, as ecological principles were continuously incorporated into plans designed to ratchet up production, and for expansion and development of ecosystems (e.g., prairie, desert, and mountainous regions) (Cronon, 2003; Kingsland, 1995; Worster, 1985; 1994). Tim Weiskel (2014) designated William Rostow (1918-2003)-type economic thinking as guiding the international development discourse. Rostow promoted “economic takeoff” as an American export (Weiskel, personal communication, 2014). “The problem was that he didn’t tell anyone where to land. This is precisely the kind of thinking,” Weiskel (2014) said, “that led to the high and unsustainable energy use we have today.”

Even after escaping a Linnaean paradigm, the linkage between economics and ecology has not traditionally obeyed models of ecological science but rather favored intensive management. Thus, the word efficiency itself, while implying conservation of resources or “doing more with less” as the Brundtland Commission suggests, has been conversely centered the exact opposite: producing and consuming more and more to feed a classical economic system. I posit the development of a different linkage between ecology and economy, based on the Malthusian paradigm discussed in Chapter 4, which

relies instead on gearing an economy around available resources, and the reduction of local-to-national human impact, as modeled on the life and work of Thoreau.

Thoreau: Economy within Ecology

Why does Thoreau devote so many pages—over eighty—to the subject of economy at the beginning of his systems naturalist treatise of life in the woods at Walden Pond? I believe it demonstrates the primary “concern” of this book is in fact economic (Taylor, 1996, p. 56). This section intends to show that Thoreau’s actions at Walden Pond to reduce or moderate his consumption were intended as a metaphor for a society that seemed to find nothing immoral or injudicious about unrestrained expansion and consumption. In other words, rather than attributing fault to the economy itself, Thoreau found fault in our fascination with materialism, and governmental and corporate unswerving devotion to it.

Thoreau believed that ideas and ethics should be lived (Taylor, 1996). Further, he believed that facts without experiences were insignificant compared to real life, and he could not accept the premise that Nature was solely something to be rearranged and used to suit human purposes (Worster, 1994a). Thoreau’s view of coupled socio-ecological systems (SES) would inspire many of his colleagues and influence all of the later systems naturalists studied in this dissertation, particularly in terms of integrating the economy with ethics and ecology. In simple terms, his philosophy is one of reducing one’s consumption in order to achieve social, economic, and spiritual harmony with nature and dignity in living.

Unexamined Consumption

Thoreau powerfully drives home the point that in and of itself unregulated capitalism does not provide health and wellbeing. Thoreau graduated into a predominantly dysfunctional job market. As America’s borders expanded with new land

purchases, the Mexican-American War (1846-8), and a gold rush in California (1848-1855), farmers in New England began to migrate westward. Local farms, which had covered the state of Massachusetts like a giant blanket, dried up in great numbers.

By avarice and selfishness, and a grovelling [sic.] habit, from which none of us is free, of regarding the soil as property, or the means of acquiring property chiefly, the landscape is deformed, husbandry is degraded with us, and the farmer leads the meanest of lives. He knows Nature but as a robber. (Thoreau & Cramer, 1854/2012, p. 333)

Mass production in major cities like Boston and former villages like Concord and Lowell dissipated the former and rewarding community-life (Mumford, 1926). As traditional ways of life gave way to automation, the Panic of 1837 hit Wall Street (Richardson, 1988) as well. These drivers increasingly led Americans to abandon their farms and former occupations and move to larger cities in the very early stages of “globalization” (Sullivan, 2011, p. 25), a trend that has persisted virtually unobstructed since the beginnings of industrialism to the present.

As a result of his choice of career as a natural scientist and philosopher, Thoreau would devote the great majority of his life finding creative ways to pay his bills. To make ends meet, he worked as a teacher, surveyor, and biologist, trying to unlock the secrets of forest succession as farms dried up and became abandoned. Although he would make significant contributions to the study of forest succession (Howe, 2009), his greater contribution would be illuminating what that time of rapid environmental, social, and economic change meant to humanity. So, it is not necessarily solely out of pure altruism—concern for nature, the plight of the common man, etc. that motivated him—but one of personal finances and practical thinking beyond the materialistic ends of

mercantilist New England that spurred Thoreau to embark on a mission to balance his personal economics.

When he looked at nature, Thoreau “saw not a flawless Newtonian machine” but in his affinity for historical context, he “could not avoid the inescapable awareness of violent ecological change caused by economic development” (Worster, 1974, pp. 65-6). In *Walden* (1854), Thoreau, sometimes humorously and other times rancorously, describes this result as a triple failure in the applications of logic, ethics, and economics. As Taylor (1996) points out, it is Thoreau’s frustrations with the “structure of the economy that requires us to approach nature as nothing more than raw materials to be exploited in the productive processes” that are central to his writing (p. 83).

Thoreau viewed his economic environment as offering few useful choices, and several times in both “Civil Disobedience” and *Walden*, he equates “Men” to “machines” and “slaves.” Although he personally could have remained on at the family pencil factory earning a stable income (Sullivan, 2011), Thoreau instead chose to meander from job to job as a land surveyor, a teacher, and a researcher—even famously “squatting”³⁵ (Thoreau & Cramer, 1854/2012, p. 249) on Walden Pond, next to the newly created Fitchburg railroad line and alongside the shanties of former slaves and ex-rail workers.

Thoreau famously wrote, “A man is rich in proportion to the number of things which he can afford to let alone” (Thoreau & Cramer, 1854/2012, p. 265). Thoreau knew, however, that in living modestly, one has the time to examine their lives and perform real and meaningful work for society. Thoreau later expands upon this in the beginning of his essay “Life without Principle” (the title, a play on life without morality, and life without money):

³⁵ Thoreau did not technically “squat” and illegally live like many that lived by the railroad, but legally built his house on Emerson’s property with his permission (Sullivan, 2011).

Let us consider the way in which we spend our lives. This world is a place of business. . . . Most men would feel insulted if it were proposed to employ them in throwing stones over a wall, and then in throwing them back, merely that they might earn their wages. . . . But many are no more worthily employed now.

(Thoreau & Cramer, 1863/2012, p. 592)

A few paragraphs further Thoreau writes that

[a]n efficient and valuable man does what he can, whether the community pay him for it or not. The inefficient offer their inefficiency to the highest bidder, and are forever expecting to be put into office. One would suppose that they were rarely disappointed. (Thoreau & Cramer, 1863/2012, p. 593)

Thoreau thus interpreted efficiency in terms of lasting value to a community and oneself—seeing money as a poor compensation for one’s work—and not only in quantity of output.

Part entrepreneur, Thoreau saw economic freedom, living within one’s means, and the limits of Nature as pivotal components of individual emancipation from a society dependent on expansion and consumption. Most scholars have concentrated on Thoreau’s ethics (Finch & Elder, 2003; Clark, 2012). But was the search for spirituality in nature the preeminent reason guiding Thoreau to a life of simplicity?

“My purpose in going to Walden,” Thoreau (1854) writes, “was not to live cheaply nor to live dearly there, but to transact some private business there with the fewest obstacles” (p. 212). He (1854) thus plainly tells us that he is living at Walden to obtain a good financial deal and avoid the trappings of the relentless daily grind that has emerged. Given that presently so many are choosing to live “off the grid,” Thoreau’s principles can be seen as providing a early pathway to freedom from consumption habits which enslave people and nature alike.

Thoreau anticipated contemporary ecologists and economists by describing both these systems in terms of energy, a “vital heat” that all life forms possess (Thoreau & Cramer, 1854/2012, pp. 209). Nature provided the raw materials of the system, and men and nature performed work which transferred and transmuted energy within it. In human development: (i) food, (ii) fuel, (iii) clothing, and (iv) shelter, all of which are considered the most fundamental of needs, are described by Thoreau as modes of “maintaining vital heat” (Thoreau & Cramer, 1854/2012, pp. 209-214). The first two make heat in living things; the second two are inventions of humans that maintain it. It is a return to these fundamental necessities, and their efficient use while obeying the principles of the emerging field of ecology, that Thoreau uses as the base of his economy. In his application of systems linking to economics, Thoreau intermingled natural and human economics. But more importantly, Thoreau firmly founded his discussion not on the economics of having more or less, but on the economics of necessity.

The antithesis of necessity was “luxury,” and Thoreau’s problem with the American economy lay in society’s creation of luxury from both the energy of the worker and the energy of nature. To transform these energies at faster rates and in larger amounts defined success in America; but, by definition, it was non-essential and could have magnified negative effects. “Luxury enervates and destroys nations” (Thoreau & Cramer, 1854/2012, p. 209). The problem with the economy, as Thoreau saw it, was that fruits of labor served not to empower the individual, nor serve society as Smith purported, but “that the corporations may be enriched” (Thoreau & Cramer, 1854/2012, p. 209).

It was not just the lower class that lived in poverty, according to Thoreau. In the first chapter of *Walden*, Thoreau examines three general categories of people functioning within the economic system: the owner of production, the farmer, and the landless

worker—all of whom fail to live autonomous and fulfilling lives by Thoreau’s standards. Thoreau wrote that it was not only the poor, but most people, that led “lives of quiet desperation” (Thoreau & Cramer, 1854/2012, p. 209). The wealthy to him were the “most terribly impoverished class of all;” they “spent half their life,” working just in order to afford their mere dwelling (Thoreau & Cramer, 1854/2012, p. 229). Regarding farmers, those who actually owned their land were so few in Concord that everyone in town knew their names. In contrast to Romantic views of idyllic farming culture, Thoreau described the farms using “images of decay, lifelessness, loss and futility” (Neufeldt, 1989, p. 8). “To get his shoestrings, [the farmer] speculates in herds of cattle,” (Thoreau & Cramer, 1854/2012, p. 229). Thoreau wrote, pointing to the inefficiency of even the heads of production, and the colossal amount of energy one could exert in the current system just to have a livelihood. As Minter (2006, p. 93) writes, for Thoreau, ultimately only “unspoiled nature ... offered the necessary distance from American industrial and commercial values so that the latter could be seen in their perspectives, i.e. as means, not as final ends” (Minter, 2006, p. 93).

The Economic System Alienates Humankind and Nature Alike

It cannot be denied that during Thoreau’s time in New England, the community life and roles that had evolved over hundreds of years had broken down, wasting people’s talents—of which Thoreau was quite distinctly aware (Cronon, 1983). This was directly related to his thinking that the highest consequence was the sacrifice of personal freedom. And Thoreau thought the economic system as it stood led to great waste, lamenting that settling Europeans had extirpated most native mammalian populations, that people now lived in a “tamed” and “emasculated” country, and that our aggressively expansive economic system degraded our view of the environment (Thoreau & Cramer, 1833/2012/p. 226).

The most controversial of Thoreau's passages in *Walden's* "Economy" chapter contain a parable about capitalism. Thoreau tells the short story of an Indian who starves because, although he makes a useful product—a basket—no one buys it. With his simple morality, and misunderstanding of classical economics, the Indian accuses a rich lawyer of not doing his part for society with his failure to purchase a basket. "Do you mean to starve us?" he asks. Thoreau concludes the tale by writing that the Indian had only done half the work in such an economy by weaving the basket; the other half, creating a market, was the larger part of the new and current system but lay beyond the Indian's comprehension (Thoreau & Cramer, 1854/2012, p. 254).

Thoreau, Taylor (1996) contends, believed "the conversion of the Indian is just a step in destroying them and replacing them with their manufacturing towns" (p. 22). Thoreau saw capitalism and corporations as not only having "no conscience" but also as forces for alienating humankind and nature alike (Worster, 1994a). That is why Thoreau's message opposed the first corporations that had divorced themselves from the duties and responsibilities of community life. In Thoreau's time, the building of the Fitchburg railroad had "invaded Concord and would never again be a self-sufficient world, independent of national markets and influences" (Worster, 1994a, p. 63).

The Indian parable can also be seen as representing humankind, both then and now. Worster (1977) supports this claim, arguing that Thoreau thought human beings "should strive for full measure of human dignity without severing their natural roots or forgetting their place in Nature" (p. 111). In addition to the personal loss of human dignity and utility at the hands of the economy, this parable reflected Thoreau's perplexity at how one would ever reconstruct a natural environment so "maimed" by civilization, as well as a civilization maimed by its economy (p. 9).

Thoreau's Economic Success

Thoreau knew that the natural resources found on his small Walden Pond lot could produce more than enough materials to provide a subsistence living. If self-sufficiency is ethical, as Thoreau believed, it was exemplified by the low impact of using a sustainable amount of products, which he documents carefully in *Walden*. This, then, constituted the core of Thoreau's personal economy and ethics, and produced one of the first, if not only, visions for truly sustainable living in America.

One must realize, however, that the prospect of *succeeding* in the free market, rather than *fleeing* it led Thoreau to conduct his two-year experiment on Emerson's property, investing in Walden Pond and "enhancing the value of the land by squatting on it" (p. 249). Hence, Thoreau did not buy into Smith's notion of the "invisible hand" of the market that guided individuals to further the good of society by furthering their own interests in a profitable manner. He believed that one must instead find his or her own special niche, such as in nature, which Thoreau did.

Thoreau thought the answer involved experiencing a human-nature economic system by participating in the making, recycling, or growing of every commodity in his possession, rather than work away during a sixty hour week or more—and spend thirty or more years doing it—to own his home. Further, he did not want to base his life on a theory that the quest for more wealth alone would benefit either the country or the individual but through interacting with one's own environment. To illustrate this, Thoreau argued that students should build their own living quarters, which I believe he meant both figuratively and literally.

The student who secures his coveted leisure and retirement by systematically shirking any labor necessary to man obtains but an ignoble and unprofitable leisure, defrauding himself of the experience which alone can make leisure fruitful. "But," says one, "you do not mean that the students should go to work

with their hands instead of their heads?” I do not mean that exactly, but I mean something which he might think a good deal like that; I mean that they should not *play* life, or *study* it merely, while the community supports them at this expensive game, but earnestly *live* it from beginning to end. How could youths better learn to live than by at once trying the experiment of living? Methinks this would exercise their minds as much as mathematics. (Thoreau & Cramer, 1854/2012, p. 342)

Not only is Thoreau saying we should learn by working on real-life projects, he is also conveying that the “foundation” of both living and learning must be a part of something one can touch and feel from beginning to end. It is the largest investment of oneself. We should also be able see and understand the results of our labor. He thought society should also live in a more direct way with the material things on which it depends. Without this real-life experience, the great majority of people, and subsequently the national economy, were not anchored to the natural world or anything of real value. Thoreau ends the passage, chastising American economics and education simultaneously in a manner with which we can certainly identify today. “The consequence is, that while he is reading Adam Smith, Ricardo, and Say, he runs his father into debt irretrievably” (p. 342).

Thoreau saw economic emancipation through the lens of using less, both as an individual and as a country. He witnessed not only the frustration of his Concord neighbors who participated in the global economy at great monetary expense, but with the advent of poor quality of products as well. “When I consider how our houses are built and paid for, or not paid for, and their internal economy managed and sustained, I wonder that the floor does not give way under the visitor while he is admiring the gewgaws upon the mantelpiece” (Thoreau & Cramer, 1854/2012, p. 227). He (1854)

stated that the American who had actually paid for his farm or his home “is so rare that everyone can point to him” (p. 220). Alongside his harvest profits, Thoreau diligently calculated the months of free time from his labors that he could use for his avocation, for reading, visiting his neighbors, and conducting scientific experiments, to which the rest of the book is devoted, activities that enriched his life and made it economically successful.

Economy within Ecology: Discussion and Conclusion

The economist Jevons found that technological upgrades usually lead to more production and consumption. With technological innovation, not only is the quality of something increased, there is also usually a reduced cost per unit, so consumption is increased. Given an efficiency increase, Owen (2012) has noted that unless one burns the savings, the “saved” input is likely spent on something else with its own life cycle and ecological footprint (EF).

As per capita EFs decrease, regional national and global net EFs continue to rise. As a result of efficiency-based thinking, the world is now, among other negative consequences, more complex and fragile than in Jevons’ time thereby multiplying our uncertainty in the sustainability of future life-supporting resources. Owen (2012) has recently engaged in public debates with Amory Lovins who contends that all growth can be obtained with efficiency measures. Owen (2012) says on the contrary that the only way to maintain or reduce consumption is by raising prices. Thoreau’s economic manifesto *Walden* viewed individual self-sufficiency and low impact as key to what we would today call sustainability.

“Economy” is the first chapter of *Walden*, and in it Thoreau is preoccupied with the disparity of wealth in America and the dehumanizing effects on many Americans. Yet, in the “Economy” chapter, he does not frame problems like inequity as the result of

“class struggle” as did other revolutionaries of his time, but he determines it to be the result of the pathological and avaricious relationship to the natural world. Although he once offended Emerson by saying he did not care for a society where one group of people had better quality food than others because of their wealth, Thoreau did not preach revolt (Taylor, 1996). Instead, he advanced dual macro- and micro-economic meanings in consuming less and self-sufficiency. Thoreau’s thinking revolves around not only national and international political economies but also on his own personal economics and efficiency. He uses his life experiment as a model for returning to an economy harmonious with the earth.

Systems naturalists can help address three of our largest and most problematic ongoing errors: the substitution of monetary wealth for ecosystem health and integrity, and perversely subsidizing unsustainable yields; having faith the market will ultimately correct for expected environmental externalities via the setting of correct prices; and assuming that efficiency measures alone can make us more sustainable. Thoreau, Carson, and Wilson instead promote an economy whose foundation is the natural economy. They advance a vision of sustainability that is based on the concept of operationalizing contemporary economics that internalizes environmental externalities and values that do not conflate natural capital and human capital. In its place, they recommend the combining of *efficiency* and *consuming less* in order to build a sustainable society. Wilson (1998) argues that beyond function and descriptive analysis and normative dimensions of justice, efficiency is only a “second-order” ethic and cannot possibly preserve or restore ecosystems vital for the long-term life-support systems of the planet (p. 295).

There is a paucity of evidence that an unfettered free market alone will be able to protect our ecosystem resources (Solow, 1993) and that the current approach

undervalues almost any non-tradable resource. The “non-valuation” of ecosystems is illustrated by the havoc wreaked by recent US hurricanes that caused hundreds of billions of dollars of damage to systems that were not previously valued by local governments. Even when ecosystems are valued, they are often framed exclusively in economic terms such as *natural capital* or *ecosystem services* that infer their value is intrinsically and exclusively tied to human use.

In the last two chapters, I discussed two dominant historical problems of linking ecology and economy that persist today—(i.) environmental externalities, and (ii.) efficiency-based sustainability. I have established that whether it is with regard to the institutions of industrialism, capitalism, the free market, or simply by designing sustainable practices, the naturalists of this dissertation have almost always demonstrated an awareness of the need to regulate economic practices. Systems naturalist thinking, co-evolving with the social sciences and humanities as they developed as disciplines, arrived at their most fundamental principles (Klein, 1990; Wilson, 1998). These complementary problems produce environmental costs that take place *outside* mercantilism and trade as it took place during the settling of the United States and in the coal industry in England, a legacy the “Enlightened” Western world has yet to escape.

The next chapter on sustainability educational theory discusses how science and ethics must be linked through transdisciplinary academic institutions to achieve that end. Leopold believed in elevating our dependency on ecosystems as a whole, as well as advancing the idea of the inherent value of appreciating what we cannot yet fully understand. Such concepts should guide sustainability planning. As Wilson (2006) writes in *Creation: An Appeal to Save Life on Earth*, “because we are part of it, the fate of the Creation is the fate of humanity” (p. 14). However varied our theories and

practices may be, the ultimate end of both species and human beings will ultimately be the same. This suggests that the threat of socio-ecological collapse, and scientific and ecological principles, should guide sustainability education. The writings of Leopold, Carson, and Wilson, I argue, meet the challenge of colossal changes in the post-WWII SES relationship. Their work can be used to advance an educational platform that synthesizes human and ecosystem wants and needs for sustainability educational theory. These writers respond with an entirely new paradigm for education and its integration by meeting both the needs of ecological limits and social equity based on the validation of foundational ecological principles.

CHAPTER 9: NORMATIVE SUSTAINABILITY EDUCATIONAL THEORY (PRINCIPLE #5)

Hartmann (1995) and the United Nations Environment Programme (UNEP) have estimated that the world's population will level out at 11.5 billion people, far beyond the earth's carrying capacity threshold, giving more credence to a non-UN and alternative framework for sustainability education. As developing countries continue to emulate the economies of America and other developed countries and the global middle class continues to grow, over-consumption will increase and decimate the ecologies of many biodiversity hotspots (Brown, 2011; McKibben, 2009; Wilson, 2002).

Surpassing local-to-global carrying capacities also means surpassing local-to-global thresholds. Ecologists and resilience theorists Walker & Salt (2006) define *threshold* as “a limit in a socio-ecological system, that when crossed, the system begins to change and feedback with its component parts and a different structure so that it enters into a new regime, i.e. ‘changing too much’” (p. 11). These regime changes significantly impact all systems and populations that rely on the ecosystem's services. In addition to the stress put on ecosystems by over-consumption and overpopulation—often aided by new technologies—climate change is expected to create up to one billion environmental refugees due to sea level rise, flooding, drought, and desertification, among other causes (personal communication, 2014; Rees & Wackernagel, 1992; 2011; Wilson, 2002).

Whereas the last two chapters discussed economic practices, this chapter turns to sustainability education. Sustainability educational theory should produce educational profiles that can prepare current and emerging socio-ecological challenges. Systems naturalists suggest sustainability education needs a guiding theory like Norton's (2005) normative theory—and exemplified by Aldo Leopold—which will fully address surpassing ecological thresholds. However system naturalists suggest a framework in which the home, or most fundamental, discipline is the ecological sciences, unlike Norton's which

is rooted in political sciences, and the very anthropocentric notion of "maintaining options." System naturalist educational theory also has less to do with trading-off, and it is less centered on efficiency and short-term payoffs.

This chapter takes another look at the Dust Bowl, intended to illustrate how the findings of modern ecological and scientific theory discovered during the 1910-1940 period were not followed (Kingsland, 2005), and instead a productivity framework, (much like the one instilled by Pinchot at the turn of the twentieth century, which adhered to a legacy of conquest and settlement) had severe consequences for the Central Plains (Kingsland, 2005). Then I examine how Leopold's lessons learned during this period, helped developed a normative sustainability theory that the pathway to social integrity is through ecological integrity and resilience. This can be a foundation for sustainability educational theory, and will be complemented by transdisciplinary theory in Chapter 10, which more specifically describes the systems naturalists' necessarily transdisciplinary system as a uniting the three branches (especially principles of science and ethics) and uniting theory and practice.

In an age where forestry, fisheries, and agriculture were becoming increasingly mechanized and over-taxed, Aldo Leopold promoted combining science and ethics in our education for land and community health, by asserting a *normative sustainability*-based platform (Norton, 2005). This great social and ecological thinker has helped introduce new interdisciplinary fields that link the three branches (the natural sciences, social sciences, and humanities), theory and practice, and academia to community to provide a strong foundation for transdisciplinary education. Leopold asked, "is education accomplished only on blackboards?" (Callicott & Freyfogle, 1999, p. 125). In *Sand County Almanac* (1949), like in many other iconic works by systems naturalists, Leopold

creates an educational paradigm that is transdisciplinary and centered in normative sustainability theory.

Like the previous chapters, this chapter is divided into two sections. First, I examine the roots of problematic sustainability educational theory shaped by *weak sustainability models* and trade-offs that ultimately sacrifice both ecosystem and human health and integrity (Norton, 2005). Then, I cite examples of how systems naturalists' educational perspective is founded in ecological principles that fulfill human equity imperatives. The work of the systems naturalists, I argue, leads to a vision of sustainability educational theory based on teaching normative sustainability. Normative principles acutely imbued with the human impact on the ecosystems and the ecosphere as a whole, can guide sustainability educational theory. But, first I will examine some of the historical assumptions about knowledge and value in the sciences and the humanities, the inheritance of which systems naturalists' thinking can help overcome.

Problematic Weak Sustainability Pedagogy

To be effective, sustainability education cannot be limited to university discourse but must influence the bulk of human behavior to have real consequence. My primary illustration of weak sustainability—and the failure to link university knowledge and real-world practices—happens on a national level. Weak sustainability, according to environmental philosopher and ethicist Bryan Norton (2005), fails to maintain natural capital, socio-ecological resilience, and the “maintenance of options” (Norton, 2005, p. 314). It is not based on a scientifically sound view of the ecosphere and ecosystems as demonstrated in Figure F.

Sustainability	WEAK	STRONG ECONOMIC	STRONG	NORMATIVE
Home Discipline	Mainstream Economics	Ecological Economics	Systems Ecology	Policy Science/ Environ. Ethics
Paradigm / Key Concepts	Welfare Economics	Welfare Economics	Welfare Economics	Complex Dynamic Theory/ Adaptive Management
Definition	Maintaining Wealth (Solow econ.)	Weak Sustainability+ Maintaining Natural Capital	Weak Sustainability+ Maintaining Resilience	Weak Sustainability+ Maintenance of Options
Key concepts	Non-declining Wealth	Maintaining Natural Capital	Maintaining Resilient Ecosystems	Integrity of Place/ Community Involvement

Figure F. Norton Simplified. A simplified version of Norton’s four forms of sustainability (2005, p. 314).

The following discussion looks at how a weak sustainability model led to the national environmental disaster in the 1930s called the “Dust Bowl” in the Central Plains. A good example of how weak sustainability theory has played out in practice occurred nearly 80 years, and resulting in possibly the first modern socio-ecological tragedy in the United States. Preceding “the Dust Bowl,” (1934-1940), farmers and ranchers were given 4,000-acre parcels in the original federal Homestead Act (1862). They transformed the land through enormous cattle drives that destroyed many endemic plants and animals; eroded the soil and the loss of nutrient-rich topsoil; and disturbed river beds whose flow was already greatly diminished due to expanding settlements (Worster, 1979). In 1909, Congress passed the Enlarged Homestead Act that granted settlers 320 acres of “dryland farming” and brought thousands of “sod-buster” settlers to the main area from 1910-1930, who would irrevocably alter the biotic community of the West. Vast irrigation networks eventually diverted the flows of the West’s major rivers.

However, only a few independent farmers were successful on these dryland farms (Worster, 1979).

Although a number of university disciplines had identified science-based sustainable land management practices, they were not practiced in regional agricultural policies and practices (Kingsland, 2005; Worster, 1994a). From the outset, many western resources were framed only within the context of the wealth they could provide a homesteader or the government. In the twentieth century, Pinchot-style and scientific management for national commodities was regularly applied “not only to forests but to other ‘useful’ components of the landscape: river systems, agricultural soils, rangelands, sport and commercial fisheries, and scenic areas . . . as new laws, policies, and bureaucracies were created to promote sustained yields . . .” (Meine, 2004; Worster, 1994a, p. 20). Sustainable management practices included the Jeffersonian method of crop rotation, such as rotating legumes and alfalfa with wheat to build a more sustainable humus soil, contour plowing (Meine, 2004), and allowing the rotation of significant-sized patches of land to lie fallow annually (Meine, 1988).

Historians generally agree that the lack of sustainable practices was due in large part to early Americans’ failure to understand the ecology of the Central Plains. They also assumed that the agricultural principles of the East and its temperate climates could be applied to the Southwest by the mere addition of water (Worster, 1979). To make matters worse, “progressive farming” followed the 1929 stock market crash. This drove machinery-intensive farming practices to increase national wheat production from 112 to 375 million bushels in the three years from 1929-1932 alone (Worster, 1979), which led to the widespread practice of mono-agriculture farming. This would, in time, cause the land to wholly lose its resiliency.

As environmental historian Donald Worster (1979) puts it, the Dust Bowl signified “the final destruction of the old Jeffersonian ideal of agrarian harmony with nature” and created over 100,000 ecological refugees (p. 45). As this situation demonstrates, SES collapse can be the product of weak sustainability; in order to contravene such an outcome, a vision that integrates science and ethic for sustainability educational theory is required.

Leopold’s Normative Sustainability

In *Sustainability: a Philosophy of Adaptive Ecosystem Management*, Norton (2005) defines normative sustainability through the life and work of Aldo Leopold as well as differentiates between strong and weak sustainability. Leopold may have often negotiated with a more “sustainable yield” or “green jobs”-type of sustainability thinking in practice, and his early prose often speaks of experimentation, and anthropocentric and utilitarian values. Yet his work in *Sand County Almanac* (1949) suggests that Leopold’s foundational principles were built on ecology and the life sciences; the maintenance of resilience, including ecosystem options; and involvement with the natural community as well as with the social community. Leopold’s “normative sustainability” as described by Norton (2005) actually comprises Leopold’s educational framework. Leopold believed that contemporary education was suspect and that a wealth of environmental education opportunities could be found in one’s own backyard. Most importantly, he contended wildlife education, land education, and social philosophy comprised all one in the same (Leopold & Callicott; 1939/1949, p. 193).

Norton (2005) builds on Leopold’s work, presenting “normative sustainability” as the strongest form of sustainability. Norton defines normative sustainability as being guided by policy science and environmental ethics; a complex systems theory and adaptive management paradigm; the maintenance of “options;” and integrity of place

and community involvement (see Figure F.; Norton, 2005, p. 314). While Norton's (2005) interpretation of Leopold has in many ways helped steer my thinking on how naturalists can contribute to sustainability, I take issue with some points that may simplify his astoundingly comprehensive and transdisciplinary (but also rather complex and enigmatic) interpretation of Leopold and adaptive ecosystem management in *Sustainability*. I instead describe Leopold in terms of a restorationist and preservationist –based sustainability platform.

In “Chapter 6: A Paradigm of Interdependency,” I argued that the theory presented in Leopold's *Sand County Almanac* (1949) resisted trade-offs between economic and environmental values. Norton's (2005) vision of adaptive management seems incremental in the face of today's SES and sustainability challenges, as well as failing to adhere to the principle of “no testing ground” of Levin's (2005) super-wicked problems like climate change, biodiversity loss, and population growth and land diminution (see Chapter 1). Leopold expressed concern about trade-offs but did not live long enough to see how these three problems became exponentially worse in the twenty-first century. If he had, he likely would not be linked with the concept of trading-off. To support my case, I often draw upon Norton's (2005) less emphasized arguments on the disciplines of the life sciences, resiliency theory, transdisciplinary theory, and socio-ecological system (SES) or coupled-systems theory.

Home Discipline: Ecology

Norton (2005) establishes policy science and environmental ethic as the core of Leopold's teaching. I suggest that, like the other three systems naturalists, the natural sciences, ecology, and/or the life sciences were the core to Leopold's thinking. As Curt Meine (2004) points out, Leopold was surprised that ecology had taken the course it had, personally refusing to accept “the natural sciences and the liberal arts—as separate

entities” (p. 67). Among the wave of progress in the field of ecology in the 1930s and 40s, especially with regard to climax states, equilibrium and what Leopold (1935) called “ecological integrity,” he seemed to realize a dashed hope that ecology would be the basis for uniting all disciplines:

One of the anomalies of modern ecology is that it is the creation of two groups, each of which seems barely aware of the existence of each other. The one studies the human community almost as if it were a separate entity, and calls its findings sociology, economics and history. The other studies the plant and animal community [and] comfortably relegates the hodge-podge of politics to “the liberal arts.” The inevitable fusion of these two lines of thought will, perhaps, constitute the outstanding advance of the present century. (Meine & Knight, 2006, p. 272)

Written during his first visit to Germany which made him question American forestry principles which focused on increasing the “output” of forests (Meine, 2004, p. 36), the above passage represents Leopold’s realization that European and Pinchot-type conservation approaches were one-dimensional in nature, even misleading. These approaches subverted much of the positive work that had been developed in the field of ecology (Meine, 1988). In *Sand County Almanac*, Leopold denounces many of these conservationist views that were still being taught at the Pinchot School of Forestry at Yale, as well as the progressive morals of the both Roosevelts’ administrations (Meine, 1988). Leopold would see the New Deal as a path to abet environmental destruction. He felt that it intruded on wilderness for the sake of utilitarian values and threatened what would be later named biodiversity (Meine, 2004).

After the Second World War—when environmental regulation was at a standstill—the National Forest Service resumed Pinchot-type and utilitarian stances, but on a greatly accelerated level (Hirt, 1994; Meine, 1988; 2004). Roosevelt (1903), who

had worked directly with Pinchot as the first Chief Forester of the USFS, framed forests as a means to increase national wealth (Roosevelt, 1903). During the Depression, these same natural resources became a means to bail out our mistakes in the stock market and one hundred and fifty years of industrialized land use. Leopold saw this type of conservation as never achieving ecological integrity.

Still following Teddy Roosevelt's lead at the turn of the twentieth century, Truman stated that "the task of conservation is not to lock up our resources but to develop and improve them" (Truman, March, 1949, p. 1), in what amounted to another iteration of American progressivism and exceptionalism. This helped to further entrench the philosophy of the USFS and the Department of Agriculture as one of economic expansion. Leopold, who had witnessed three eras of bland conservation initiatives, gave primacy to restoration and preservation of the wild in *Sand County Almanac* (1949).

Even as early as *Game Management* (1933), Leopold recalled that private land owners were encouraged to manage farms in ways then unheard of in industrial farming. The intention was to produce the most wild and preserved places for hunters as possible with the exception of wolves, which Leopold argued should be extirpated. While hunters have traditionally been among the most knowledgeable—as well as the biggest advocates—of biological diversity to some extent, they are often willing to sacrifice predators, such as wolves, for increased game. In *Sand County Almanac*, Leopold recanted this and turned his support to the current conservation movement that favored restoration and preservationist initiatives geared at real ecological integrity.

As environmental historian William Cronon (1992) and others have written, there was a virtual war on natural predators at the turn of the century that rivaled, or surpassed, the war on insects in Carson's time. While many have interpreted Leopold's largest life-lesson romantically and as the result of looking into a dying wolf's eyes

depicted in his “Thinking Like a Mountain” (1949), I posit that a different experience changed his perspective in this essay. I believe it was his visit to Europe in 1935, which brought him face-to-face with the long-term results of Pinchot-style and European-forestry management practices.

While the Germans had succeeded in managing their forests to produce maximum and short-term economic yields, they had failed—miserably, in Leopold’s view—to attend to the diverse forest ecosystem as a whole (Leopold, 1936). When seeing the aftermath of these “sustainable” forestry practices, he described these habitats as “slick” and “clean”—in other words, very poor representations of robust ecological health (Leopold, 1936; Callicott & Freyfogle, 1999, p. 23). Upon his return to America, Leopold questioned the sustainable conservation practices that Pinchot had adopted, raising issues with the term sustainable and recanting many of the ideas prevalent in *Game Management* (1933), especially regarding predators (Meine, 1988). He didn’t compromise but leaned far more towards Muir’s preservationist camp, by then a minority in federal management services (Meine, 2004). This is the way Leopold, in fact, is generally viewed (Callicott & Freyfogle, 2012).

What Leopold realized in Europe was that the term “sustainable” reflected an ecosystem that was a shadow of its former self, greatly diminished in biodiversity, and wanting of the highly variable fruits of millions of years of natural selection. “As the ‘inexhaustible’ pineries [of the Northeast] were, in due course, exhausted” during Leopold’s lifetime (Meine, 2004, p. 15), he must have seen history of “sustainability” repeating itself from von Carlowitz to Pinchot, as he had seen for himself same results in Germany (Grober 2012). After returning from Germany he wrote, “We yearn for more deer and more pine . . . do we know that to get them, as the Germans have, at the expense of their wild environment and their wild enemies, is to get very little indeed?”

(Leopold, 1936, p. 102). It was easily as much this experience, rather than a remembered youthful hunting experience many years before, which influenced the writing of “Thinking Like a Mountain.” An essay he wrote shortly after his trip. Thus, the metaphor “Thinking Like a Mountain,” as well as the metaphor of seen the “green fire” in the eyes of a wolf he had shot in his youth, can be understood to represent long-term socio-ecological health and wellbeing achieved by respecting the biological integrity of ecosystems.

Maintaining Socio-Ecological System Resilience

Norton (2005) argues that maintaining ecosystems avails the goal of more social options and that the destruction of ecosystems limits them. He states that although sustainability necessarily includes resilience, the term is not one that appeals to social values; its premises “do little to link resilience to human values or to the day-to-day concerns of voters” (Norton, 2005, p. 51). But I would argue that while everyone may not be familiar with the term, the concept of SES resilience itself is inherently desirable.

Ask the common voter in New Orleans or New Jersey, for instance, if a candidate’s stance on economic or environmental vulnerability (resiliency’s flip-side), will affect their ballot. Better yet, ask the average American if they like low gas prices, or prefer to see prices rise to ten dollars a gallon and stay that way (a price more reflective of the true costs to the environment). These are key issues of SES resiliency. What Norton fails to express is that resilient SES systems contain social *and* ecological options, both of which can shift a socio-ecological system into a new and hardly recognizable regime (Holling, 1973).

Though little has been done to establish resiliency planning so far (Pijawka, 2015), the new educational field of resilience, a key element of normative sustainability, often includes concepts like crop diversification, allowing land to lie fallow, and

providing shelter for game in every corner of one's property for the sake of biological diversity. These concepts, often advocated by Leopold through his career, embody resilience and are what we would call built-in redundancies today. They allow SES system to handle blows unlike many efficiency-based measures. Increasingly, interconnected and complex systems, which have not been sustainably framed and planned, despite more efficient networks, crumble when shocks occur (Walker & Salt, 2008).

This type of result was obvious to Leopold. He believed that if we could understand nature better, we would see it as a valuable resource and testing-ground for human ethics within the much larger value system of ecosystem. "An ethic, ecologically, is a limitation on freedom of action in the struggle for existence" (Leopold, 1949, p. 238). As human systems grew ever more complex however, the environmental ethic also became harder to decipher:

The complexity of co-operative mechanisms has increased with population density, and the efficiency of tools. It was simpler, for example, to define the anti-social uses of sticks and stones in the days of mastodons than of bullets and billboards in the age of motors. (Leopold, 1949, p. 238)

Leopold's vision of resilience is simple and comes from a return to old practices, based on a long-term ethic of geological time (Callicott & Freyfogle, 1999). He rarely wrote without intertwining human and ecological needs, like in his (1935) pastoral—albeit largely anthropocentric—point of view, switching back and forth between ecological health and instrumental goals of human harmony with the land:

When the Cows which make the butter were first turned out upon the hills which comprise the scenery, everything was all right, because there were more hills than cows, and because the soil still retained the humus which the wilderness

vegetation through the centuries had built up. The trout streams ran clear, deep, narrow, and full. They seldom overflowed. This is the proven fact that the first settlers stacked their hay on the creek banks, a procedure now quite unthinkable. The deep loam of even the steepest fields and pastures showed never a gully, being able to take on any rain as it came, and turn it upward into the crops, or download into perennial springs. It was a land to please everyone, be he empire-builder or a poet. (p. 40)

Leopold views the foundation of sustainability in the restoration of old ways and methods and in the return to a more natural, balanced, and harmonious relationship with the land. While both Thoreau and Leopold have elements of a traditional pastoral or “Arcadian” (Worster, 1994a) view of sustainability, I feel that this is not purely romantic but rooted firmly in proto-ecological principles regarding both the science, and the ethics, of land health.

Leopold’s “Thinking like a Mountain” in *Sand County Almanac* (1949) represents a scientific understanding of an ecosystem as much as it does one of respect for what we do not yet understand. But, it also reflects on his former immaturity as an ecologist. In it, he denounces the concept of trading-off between preservationist and conservationist worldviews, which he had espoused when he wrote that predators should be extirpated, as a great threat to biodiversity. The depletion of natural resources caused by over-farming of the Central Plains likely also greatly influenced Leopold’s views.

SES Integrity

Like the ecologist Paul Sears (1935), Leopold foresaw the problems resulting these farming practices that would lead to the “Dust Bowl” devastation (Worster, 1975; Meine, 1988). He wrote later in *Sand County Almanac* (1949) how even after the lull in environmental initiatives during WWII, things still had not changed:

Many conservation treatments are obviously superficial. Flood-control dams have no relation to the cause of floods. Check dams and terraces do not touch on the cause of erosion. ... In general, the trend of the evidence indicates that in land, just as in the human body, the symptoms may lie in one organ and the cause in another. The practices we call conservation are, to a large extent, local alleviations of biotic pain. (p. 174)

Leopold proceeds to describe a litany of both government and private well-intentioned practices to show how conservation was failing.

When the Dust Bowl struck the Central Plains, Leopold knew (similarly to Muir and most naturalists thirty years before) that there had been a convergence of three key, negative environmental issues—over-farming, the erosion caused by sheep and cattle ranchers, and the disturbance of the cycles of natural forest-fire regimes (Meine, 1988). He knew this was due, in large part, to carelessness on a national level. He also knew that this was the cause of the ecological debacle, which had almost unmeasurable costs to the United States as a whole, of which the Dust Bowl was only a symptom (Meine, 1988).

The predominating Pinchot-type practice of intensive management may have provided jobs and wealth but the promise of maximum productivity kept farmers focused on shortsighted year-to-year profits (Worster, 1975). This eventually robbed the soil of all microbial life, in effect, “killing” the land across eleven states (Worster, 2008, p. 182)—an outcome that was unimaginable to most everyone. Given current environmental problems today, Leopold, alongside John Muir, would have been profoundly skeptical of any sustainability framework that reinforced the status quo and did little to encourage the protection of the land through well-considered biodiversity initiatives.

For instance, they would have recognized that good science alone would not ensure ecological health (Meine, 1988). Working with communities in Texas and Albuquerque, Leopold saw that sustainable yields in practice were usually arbitrary and not based on good ecological science. Pinchot's "sustainable" use of national parks for grazing and mining had likewise seemed counterintuitive to Muir. Rather, they would likely have promoted the dynamic use of sustainable yields to increase the productive value of American ecological tracts (Meine, 1988; Walls, 1995) and ethics as the key to building resiliency.

Social Integrity through Ecological Integrity

Because of Leopold's long view on the history of conservation, *Sand County Almanac* (1949) focuses primarily on the benefits of often unexpressed ecological values for society. But was Leopold really arguing for the compromise between social and environmental needs? As literary scholar and eco-critic Timothy Clark (2013) argues regarding Carson and Leopold,

[I]n order to be heard at all, campaigners must speak in terms accepted within existing structures of governance and economics, the very things they may consider ultimately responsible for environmental degradation in the first place. This is a recognised [sic.] syndrome in environmental politics: radical environmentalism in theory often turns into merely reform environmentalism in practice. (p. 77)

I maintain that much of Leopold's rhetoric prior to *Sand County Almanac* (1949) was aimed at swaying voters and decision makers to support particular policies. His description of the human/nature relationship tends to be *anthropomorphic*, a form of biocentrism favored among many nature writers, rather than anthropocentric (Clark,

2012). He aimed to develop human sympathy for the ecosystem in their backyard. For instance, he writes,

The mouse is a sober citizen who know that grass grows in order for mice to 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. (p. 4)

Unlike Thoreau and the other systems naturalists, Leopold oscillates between delving inside the psychology of both humans and non-humans to produce an equally amusing arrogance in mice whose future plans are dashed by a fluctuating ecosystem. The mouse's energy budget and the "moonshine economy," express the fundamental relationship between ecology and economy—that of supply and demand. In other words, an ecosystem will only bear what it can bear.

While Leopold is exercising a poetic license above, what is important is his solidification of the connection between the welfare of the human and natural economy. He describes a system of energy exchanges in the ecosystem, and an economy that is in harmony with evolutionary and ecological principles. At the same, time he expresses respect for (what most people consider) vermin, as members of his fellow community (recalling White and Thoreau).

On many occasions, however, Leopold (1949) uses virulent language (Meine, personal communication, 2013; Norton, 1999) not only in letters to the community but also in *Sand County Almanac*. Irritated at the general misunderstanding of man's relationship with nature and his embeddedness in a larger ecosystem, he states, "mechanized man, oblivious of floras, is proud of his progress in cleaning up of the landscape on which, willy-nilly, he must live out his days" (p. 50). This a theme he

repeats throughout *Sand County Almanac*, referring to the stress on ecosystems due to the destruction of biodiversity and the subsequent consequences to society.

Norton (2005) and many other sustainability scholars draw upon Leopold's thinking. The writings they most often quote are those where he was heavily influenced by Pinchot, having attended both undergraduate and graduate school programs at Yale that were founded by Pinchot's family as well as the many National Forest Service policies which Leopold would later help enforce and mold. These writings, all occurring prior to his 1935 German trip, promote compromise and patience, often speaking to people's interests especially hunting that Leopold saw as preserving biodiversity; thus they miss much of the most important insights that he shares in *Sand County Almanac*. Here, he firmly aligns the economy of humankind to the economy of nature, believing that the more simple and basic this combination could be, the better the outcome would be. Despite what has been often perceived as anthropocentric rhetoric, Leopold presents not a picture of prosperous men simultaneously preserving and living off the fat of the land, but instead paints a model of resilience in the preservation and restoration of old places and ways.

Normative Sustainability: Discussion and Conclusion

Scientific advancements in agriculture and new practices like mass chemical fertilization contributed to the collapse of the agricultural belt in the United States. Likewise, the fragility of biotic communities collided with conservation laws geared towards newly authenticated agricultural and ranching efficiency and the steady increase in the production of yields (Meine, 2004; Worster, 1977; 1985). Monocropping, especially of certain strains of wheat, and the mass production of agricultural equipment designed for efficiency per acre and maximum yields also added to the SES problem. These inappropriate practices ultimately resulted in collapse.

Most countries have not considered humankind's ethical obligation to nature when creating land-use policies. Instead, they focused on turning American ecosystems into wealth, a fact of which Leopold was acutely aware (Worster, 1949). Norton (personal communication, 2014) has publically debated J. Baird Callicott, an eco-centrist and defender of Leopold's non-anthropocentric worldview, as the source of Leopold's moral stance. While Leopold has been theorized as uniting with preservationist and conservationists (Minteer, 2003; Norton, 2006), he exhibits a lack of confidence in conservation practices and asserts a predominantly restorationist and preservationist agenda when his theory in *Sand County Almanac* is further considered, despite having succumbed to "conservationist" theories and practices early in his career.

Tim Beatley, author of many foundational sustainability books including *Resilient Cities: Responding to Peak Oil and Climate Change* (2009) and *Biophilic Cities: Integrating Nature into Urban Design and Planning* (2010), has been devoted to examining SES from the urban planning perspective. Contrary to Cook and Redman, he expressed the idea that:

As an overarching framework in which we *can* make tradeoffs, we must remember that a framework is an *overarching* thing and not expect it to be a *defining* thing. We can no longer tolerate thinking that it's just about cost-benefit analysis, and counting beans—then we've missed the point. Sustainability is about making tough choices. At the end of the day you might have to sacrifice part of that environment, but sustainability must also include the fact that there is intrinsic value in natural things, there is a sense of something beyond ourselves, and that there is great joy in connecting with nature. (Beatley, personal communication, 2014)

In other words, the concept of sustainability is not clear and objective when it comes to tradeoffs, but tradeoffs do not need be the defining aspect of sustainability.

In describing Leopold's SES worldview, I have endeavored to display the long-time philosophical and scientific oppositions found in the study of nature and culture. In Chapter 1, I described how contemporary environmental philosophers Ben Minteer (2006) and Norton (2005) have used Leopold's demonstrated environmental pragmatism to solve for conservation vs. preservation dichotomies in decision-making.

Leopold's educational platform calls for preserving ecosystems, rather than wealth as per Norton's (2005) normative sustainability. Unlike Norton (2005) and Minteer (2006) who have stressed Leopold's practices of experimentation in actual sustainability practices, however, I suggest that such compromises are not commensurate to the magnitude of SES problems. Instead of examining where diverse views had converged into actual environmental policies, I focus on Leopold's theoretical views expressed in *Sand County Almanac* (i.e. his most mature views (see Chapter 1: "Four Naturalists" section) as firmly positioned in restoration and preservation. I stress that these views do not compromise ecological and social integrity with trade-offs but see them as one in the same.

Leopold had a greatly simplified view of the relationship between humans and the environment, and thus sustainability thinking. He captured his principles on ecology, economics, science, and ethics in one swoop when he said, "the truth is that which prevails in the long run." Like his views on ethics, his views on ecological health have greatly simplified the concepts for those without a foundation in ecology. Unlike his predecessors, Leopold demonstrated "the full range of values as projected into the indefinite future" (Norton, 2005). Norton and Callicott concur on Callicott's statement about naturalists, "Moral knowledge came to be part of their naturalistic thinking . . .

naturalism as a philosophy deserves a more prominent place in considerations of land ethics” (Knight & Reidel, 2002).

Next, I’ll discuss how weak sustainability models have resulted in part from university models that fail to connect knowledge from the three branches, and link theory and practice. I will focus on the struggle against compartmentalization that began shortly after WWII, and new attempts to link science and ethics. In the next chapter, I once again employ the writings of systems naturalists Rachel Carson and Edward O. Wilson to display how human and ecological aspirations converge over the long term. They also demonstrate how the principles of science and ethics must be joined, not compromised, in guiding sustainability and transdisciplinary education. These two post-WWII activists, scientists, biologists, public intellectuals, and self-proclaimed naturalists center their principles of the future convergence of disciplinary knowledge and values within transdisciplinarity.

CHAPTER 10: TRANSDISCIPLINARY EDUCATION (PRINCIPLE #6)

Despite Leopold's ability to resolve Pinchot/Muir-type dichotomies, contemporary sustainability theory has persistently expressed two polarized worldviews. At one end of the spectrum is an environmentally driven approach that emphasizes conservation and precaution, giving rise to small-scale and ecologically based solutions. The opposing paradigm is a more technocratic and cornucopian approach which is market- and growth-driven, stressing risk and technological innovation (Costanza, 1991; Kates & Parris, 2003; Conway, Keniston, & Marx, 1999; van der Hamsvoort & Latacz-Lohmann, 2006; Worster, 1994a). As Edward O. Wilson (2002) writes, "These stereotypes cannot be simply dismissed since they are so often voiced and contain elements of real substance, like rocks in snowballs. But they can be understood clearly and sidestepped in the search for common ground" (p. 152).

Sustainable development education (ESD) has reflected the technocratic and cornucopian framework of the United Nations (UN)(Thomas, 2009). In the recent UN "Post 2015" Report, for instance, the authors made it the normative mission to protect Lowest Developing Countries (LDC), now been hit hardest by population growth in the (UN, 2013). But, in order to preserve LDC, the UN imperative as stated is to provide countries of lowest socio-economic development by primarily acquiring "technologies for health and wealth" (p. 4). The UN's mission encourages "the fair distribution of new and appropriate technologies [to] promote steady improvements in living conditions, which can be lifesaving for the most vulnerable populations, and drive productivity gains which ensure rising incomes" (p. 1).

Like many UN documents, this report conflates wealth and technological advancement with sustainability and science. While such documents are aimed at addressing the social equity between global North and global South, they fail to include

the notion that science and technology should be geared at preserving and restoring natural systems that civilizations have depended on for centuries. In addition, while speaking broadly of “science,” the “Post-2015” report does not refer to the basic needs of humans and ecosystems themselves, as integrated socio-ecological problems like climate change, population growth, biodiversity loss, and lower local-to-global carrying capacities, as if science sole role concerned advances in engineering research and development.

As discussed in the previous two chapters, scientific and technological developments cannot be compartmentalized. Instead, they are inextricably tied to the normative values of sustainability (Kates & Parris, 2013; UN, 2013; Vucetich & Nelson, 2009). Put another way, “the necessity of looking at nature through a variety of disciplinary lenses brings with it a variety of normative lenses, as well” and thus includes more than just an increase in wealth or technology (Sarewitz, 2003). Narrow explanations of health and wellbeing limited to donations of money, medicine and technology from the developed world (as in the “Post-2015 Report”) are not likely to capture all of the normative lenses required for sustainability education.

Systems naturalist principles are essential to the creation of a sustainability educational paradigm based on staying within the carrying capacity and preserving biodiversity, and therefore our life-support systems. Yet, health and wealth are too often equated with new technologies. In *Too Smart for our Own Good: The Ecological Predicament of Humankind* (2012), philosophy of science scholar Craig Dilworth exposes that thinking among society and educators alike are often too enthralled with technology at the expense of fundamental life sciences such as geology, genealogy, chemistry—and most importantly for this dissertation—biology and ecology. A study of naturalist literature suggests the need to understand in sustainability thinking that

technology is *not synonymous* with science (nor wellbeing), but it is actually the *application of science* (Weiskel, personal communication 2014).

Only a small subset of current sustainability education focuses on what Kates, Travis, & Wilbanks (2011) call “transformative action” (p. 7160), and Ison and Russell (2000) “second-order change” (p. 47). A more transformational stream of education involves substantively reimagining sustainability through a change in perception that goes beyond simply protecting ecosystems and encouraging practices that reduce use and consumption. Transforming old educational systems has also been elusive (Klein, 1990; 2006; Wilson, 1998). Universities currently have little guidance on how to approach the complexity of integrating disparate subjects such as sustainable design, energy, economics, and environmental management with cultural programs that address important issues like ethics, history, food, and health (Pijawka et al., 2013, p. 24).

In this chapter, I also examine how Carson (1962) and Wilson (1998) take into account a comprehensive view of ecology in air, riverine, ground water, climate, biological and cultural diversity, and health that integrates ecological and economic sustainability. But first I look at *compartmentalized knowledge* that eclipses valid supplementary knowledge from other fields (Newton & Freyfogle, 2005; Norton, 2005; Miller, 2009; Sarewitz & Light, 2008; Wilson, 2002).

Problematic Compartmentalized Knowledge in Sustainability Pedagogy

Unchecked population growth, over-consumption, and ecosystem loss is due in part to the weak link between science and environmental ethics (Wilson, 1998), compartmentalization in academia, and “anarchistic pedagogy” that fails to connect communities to institutions for real-world problem-solving (Segala & Tejedor, 2013; van der Leeuw et al., 2012, p. x; Wilson, 1998). Here I argue that since systems naturalists have traditionally been *the* authority on ecological limits and thresholds, they are best

equipped to guide a sustainability education centered on SES problem-solving and bridging communities and academic institutions, for the problem of rising consumption rates.

“Increasing specialization marked the years 1945-1965” (Meine, 2004, p. 37). This was true in education as well as industry. During this same period, however, some scholars saw the need to reunite our knowledge systems, like Carson’s (1962) revolutionary view of integrated earth, air, ocean, and riverine systems. In another example, the astrophysicist, social scientist, and philosopher Erich Jantsch (1957) had a vision of cooperation and “mutual enhancement of epistemologies” (2007, p. 7). In a third example, Holling’s work as early as 1969 also linked natural and social sciences in new fields like urban ecology and subsequent concepts like resiliency, adaptive capacity, transformation, and transdisciplinarity.

In the early 1970s, the environmental movement would be marked by similar polarization. Within a few years of the first Earth Day in 1970, many social and environmental advocates disagreed about the approaches needed to interpret and solve environmental issues (Sale, 1993). One approach to environmentalism favored an *environmental justice* worldview and stressed social concerns. The other, led by the philosophy of deep ecology, went further than previous preservationists. This approach favored the spiritual values of Nature on scientific and ethical grounds and lauded its intrinsic values as its most prized asset; its protection was perceived as the only way to preserve the planet. Along with seminal articles like Christopher Stone’s “Do Trees have Standing” (1972) and John Rodman’s “Liberation of Nature” (1977), deep ecology promoted the extending circles of ethical inclusiveness to nonhuman animals whose cognition and actions greatly resembled humans, as well as a “moral pluralism” (Hay,

2000, p. 124; Light, 2002, p. 197-211). Only later did the US embrace the UN's idea of social and environmental spheres with the *Brundtland Report* (1987).

The social field of environmental justice captured momentum during the Reagan Era of the 1980s. The public became skeptical of what was thought to be the bio-centric or eco-centric views that placed ecosystem health and welfare above that of disproportional wealth and poverty alleviation, often framing environmentalism as a luxury of the educated elite in developed countries. Environmental justice also placed precedence on the distribution of the environmental costs and benefits unequally between the Global North and Global South, as well as disparities within both spheres (Boone & Fragikias, 2013). Environmental justice advocates in the UN, although viewing the depletion of natural resources as a dominant concern, seemed to focus on social programs designed to increase transparency and encourage pluralism in decision making as the cure, rather than the obeisance of strict ecological limits.

At the other end of the environmental spectrum lay *deep ecology*, which was often embraced by educators in the humanities as it enabled them to contribute findings from a deep philosophical tradition fashioned as a new “method of inquiry.” *Ecocentrism*, became a concept that defended “the ecosphere as a whole” (Næss & Sessions, 1984, p. 5). A number of ecologists also argued that this would help answer SES problems (Hay, 2000, p. 41). Norwegian Arne Næss (1925-2009), introduced the term “deep ecology” in “The Shallow and the Deep” (1973), reviving Spinoza's interpretations of all “particularity” within Nature as equal in value (Hay, 2000, p. 26).

Deep ecology was an example of a contemporary “form of anti-science”--much like Transcendentalism (1825-1840), which broke down existing dualisms of “subject/object, self/other, ideology/science, and human/nature” (Taylor, 1996, p. 264). However esoteric, Næss (1973) described concrete differences between deep and

“shallow ecology.” For instance, with regard to pollution, a *shallow* approach would seek a technology to help purify emissions that cause acid rain, while a *deep* approach would attack the causal economic and technological mechanisms responsible for the diminishment of ecosphere integrity. More often than not, a transformative vision like that of deep ecology is often perceived as being unrealistic.

The term *transdisciplinary* was a promising term to unite different modes of educational theory, and was also first introduced during this period. It was first put forward by the Organization for Economic Cooperation and Development (OECD) in 1984 (Klein, 1984). Much like the *Brundtland Report* (1987), this body had an implicit mission of development (Walker et al., 2004). But it would later be embraced by other thinkers like the ecologists and systems-thinkers Howard and Eugene Odum (in search of a more conservation-biology-like perspective) described transdisciplinarity as “unlocking of cause and effect explanations across and among disciplines” (Odum and Barrett, 2005, p. 13).

Although the new twenty-first century field of sustainability science embraces the theory of transdisciplinarity for transforming education systems, in reality, true transdisciplinarity has hardly begun to be achieved now, let alone grapple with the kind of complexity that SES problems demand today (Miller et al., 2008; Redman & Wiek, 2013; Thomas, 2014). Like the environmental movement and theoretical sustainability, fields of sustainability within the university can present polarized philosophical—rather than scientific—approaches needed to interpret and solve real environmental issues (Dryzek, 2005).

Wilson (2015) goes further to link specialty and intense disciplinary work to financially back and sell classes to the students, from “search committees” to “dean” to

“President” and ad hoc committee” guides the creation of knowledge in the university (p. 40):

[W]estern intellectual life is ruled by hardcore specialists. At Harvard University, for example, where I taught for four decades, the dominant criterion in the selection of new faculty was preeminence or the probability of preeminence in a specialty The pivotal question asked was, “Is the candidate the best in the world at his specialty?” On teaching it was almost always an easy going, “Is the candidate adequate?” The guiding philosophy overall was that the assembly of a sufficient number of such world-class specialists would somehow coalesce into an intellectual superorganism attractive to both students and financial bankers. (p. 40-1)

Renowned sustainability educator David Orr (2004) has criticized sustainability education as teaching students “merely to be more effective vandals of the Earth,” suggesting a violation of both the ecological and normative aspirations of sustainability (p. 1). Orr (2004) has also presented yet another dichotomy of sustainability, like that within sustainability theory (e.g., “Figure A. Environmental polarizations” from Chapter 4). After many years working in academia and the field, he has concluded that two opposing worldviews exist in academia. The first worldview frames nature as a resource and as the objective subject of natural science. The second worldview perceives nature as a subject of the humanities, and thus as the source of nutrition, art, society, and who we are. In his opinion, these spheres should be united.

The values of beauty and utility need to be combined in order to achieve “permanence” (Orr, 2004, p. 56). Yet, universities in general have spent the last 150 years encouraging consistently greater degrees of specialization. This is in large part due to the longstanding structure of university programs that reward specialization and

disciplinary behavior (Wilson, 1998). Advantaging traditional single “disciplines” has, first, fostered entrenched and isolated department silos and, second, fragmented institutions resulting in the rigidly disparate fields of knowledge that we have in the university system today (Wilson, 1998, p. 11; 201-5; pp. 291-3).

Finally, in order to consolidate knowledge, the university system has reinforced the idea of “trading-off” between social, environmental, and economic values, which amounts to a weak and incremental sustainability platform, and persistently veers toward models based on economic growth, efficiency, and raising the standard-of-living as a means for solving SES problems (McDonough & Braungart, 2006; Owen, 2012; Svava, 2010). To reverse this trend, the sciences, social sciences, and humanities must be integrated, building on the important and continuing foundational work of these disciplines (Wilson, 1998).

Sustainability scholars Wiek and Redman (2013) assert that sustainability, although it is in very early stages of development, “should be the goal of our efforts in education and in broader society” (p. 215). Transforming education to go far beyond the university walls, and escape older disciplinary models for education is part of sustainability education’s (EfS) stated mission (Thomas, 2014). Many other sustainability scholars like Frisk and Larson (2011) have called for a complete transformation of how we view institutional and education systems.

Rachel Carson, like Thoreau and Leopold, was guided by a moral duty to the environment and human beings, an approach inspired by a transdisciplinary understanding of human ecology, and humankind’s place in ecosystems. It was out of her sense of duty to nature that Rachel Carson would drop her poetic and bio-centric prose regarding the meeting place of land and ocean to focus upon how to maintain ecological *and* human health and wellbeing in the onslaught of unregulated scientific and economic

forces. On the other hand, E. O. Wilson drops his authoritatively scientific voice in many books and articles to adopt a humanistic point of view that complements his empirical and deductive side. Especially in the *Future of Life* (2002), Wilson prescribes exactly how to maintain our vital ecosystems by not only preserving and restoring biodiversity hotspots around the world but also by raising the standard of living in developing countries and making them environmental stewards.

I posit that integrating socio-economic fields and the natural sciences within sustainability education can arrive upon principles that can help transform education and make it more transdisciplinary in order to address our most challenging, and competing, SES problem areas. In the next section, I examine how each of the systems naturalists conflated emerging scientific findings with practical ethical discourse, how they contended with the challenges of a worldview bound to technological expansion that contained an inherent ethic of progressiveness, and how they provide examples for understanding science and ethics as complementary systems to guide sustainability education.

Carson and Wilson: Transdisciplinary Sustainability Pedagogy

Today—even in interdisciplinary institutions and schools—scholars often take deep-rooted and theoretical views, which ultimately be seen as playing out in real-world practices. One view is a cornucopian and technocratic approach, which is market- and growth-driven, stresses risk and technological innovation, but does not fundamentally challenge or change the way our major socio-ecological systems operate (Kates & Parris, 2003; Conway, Keniston, & Marx, 1999; van der Hamsvoort & Latacz-Lohmann, 2006). The other view is that business-as-usual will one day make the world “uninhabitable” (Dryzek, 2005).

It is the systems naturalists' scientific study of human behavior and ethics as part of nature that may bear the greatest consequence to sustainability education. They provide examples of how science and ethics can be understood as complementary systems. For instance, Wilson (1998) believes that the combination of scientific theory, practical social inquiry, and creative and academic investigation (exemplified, for example, by the four systems naturalists of this dissertation) link science and ethics in a way that is necessary for survival today.

In this discussion, I first interpret the systems naturalists' planetary ethic as rooted firmly in ecological science. This applies to how we view sustainability education as well as how we integrate knowledge and values from ecology and the humanities into it. Afterward, I examine how the systems naturalists' balanced environmental concerns address advances in technology, growth in population and consumption, and new ethical dilemmas (a.k.a. *consilience*, as Wilson [1998] would call it), especially regarding the myth of technological advancement leading to a flourishing utopia. Systems naturalists present a guiding set of principles aimed toward preserving biodiversity and cultural places, which I first discuss and finally through Carson's and Wilson's integration of academic disciplines.

Sustainability as an Epistemological Spectrum

Carson's lifetime of ecosystem analysis and description testifies to her emphasis on the need to educate the public on the importance of ecological integrity and the consequences of disturbing important ecosystems. Like all the systems naturalists, Carson was a true transdisciplinary. But she emerged as a writer just as the American government began exponentially ramping up industrial production. The wide platform of Carson's attack on irresponsible behavior of both government and industry in America reflects her knowledge and would legitimize her in the eyes of Americans as well as

President John F. Kennedy (1917-1963), who publically acknowledged her importance (Lytle, 2008).

Before Carson (1962), no one could conceive of a marine biologist and nature writer bringing a halt to the unrestrained forward progress as America led the contemporary global economy (McKibben, 2006). However, her description of bioaccumulation and the illustration that human pollutants and poisons relentlessly migrated up the food chain and into human beings themselves in *Silent Spring* (1962) brought attention to the dire need for restraint. When Carson set out to win the hearts and minds of American government officials and scientists—and the American people from housewives to experts intellectuals within academia and industry—she knew she could not make some generalized rant about the awful power of industry (Lear, 1997). She knew that she must employ a broad spectrum of comprehensible knowledge in order to make her point (Lytle, 2008).

In the political arena of *Silent Spring*, Carson, like Leopold, always tied ecological needs to human needs. Carson read reports from various government and industry representatives that revealed the covering up the harmful effects of industrial chemicals (Souder, 2013). Agricultural industry and government departments had declared a war on the cyclical influx of insects with the widespread use of dichlorodiphenyltrichloroethane (DDT). These battles often destroyed ecosystems as well (Carson, 1962).

While the evidence had been around for a while, Carson's message was possibly the first transdisciplinary perspective on a core environmental problem. Bolstered not only by her heavily researching ornithological histories, she also explored a wealth of scientific disciplines, such as endocrinology, epidemiology, hydrology, and industrial practices. Collecting thousands and thousands of manuscripts and corresponding with

authors for verification (Lear, 1997), each chapter of *Silent Spring* (1962) presents a different angle. The book begins with a broad overview, then a chapter on nuclear, air, water, soils, and rivers³⁶ – all demonstrating that every chemical released into the air, water, or soil becomes universally distributed around the globe. Carson's (1962) revealing work and critique of the widespread use of DDT would spearhead a new environmental platform.

By educating average Americans across a range of topics, she rapidly influenced business-as-usual practices. The contrast to the almost complete lack of regulation in 1962 to fifteen years later is striking.³⁷ Even the ultra-conservative President Richard Nixon (1913-94) would later rank among the most environmentally progressive presidents because of the passing of environmental legislation during this era. While in the beginning of the controversy, the nation became entrenched in familiar economist vs. environmentalist positions, Carson's (1962) case was so compelling that within two years laws against the application of the more dangerous pesticides were passed in over 40 states (Souder, 2012).

Carson concluded that although technologies evolved much faster than ethics among decision-making bodies and the public, it was high time for science and technologies to cease being viewed as the supreme authority. As biographer Linda Lear (2009) writes in the introduction to *Silent Spring* (1962),

³⁶ Chapter 3 of *Silent Spring* (1962) discusses chemical pollution; 4 discusses groundwater pollution; 5 discusses soil pollution; 6 discusses adverse effects on the biosphere in general; 7 discusses the lack of political transparency; 8 focuses on bird habitats; 9, riverine systems; 10 air pollution, and so on.

³⁷ A number of the most well-known pieces of legislation during this time included the Clean Air Amendments of 1970, the establishment of the Environmental Protection Agency 1970, Federal Water Pollution Control Amendments of 1972, the Endangered Species Act of 1973, the Safe Drinking Water Act of 1974, and the Resource Conservation and Recovery Act of 1976. National environmental policy was promulgated through the 1969 National Environment Policy Act that had a global influence and provided a process for decisions regarding environmental impacts.

The public endowed chemists, at work in their starched white coats in laboratories and factories, with almost divine wisdom. The results of their labors were gilded with the presumption of beneficence. In post-war America, science was god, and science was male. (p. xii)

Environmental and social problems in Carson's time were often viewed as occurring in a vacuum, i.e., as completely separate problems. Like the other three naturalists, Carson was skeptical of technology. As a result, it was Carson who really blew the lid off industry and government's lack of ethics when it came to environmental externalities. Carson's recent biographer Stewart Lytle (2006) writes in *The Gentle Subversive*, that "in the atomic age, she grew ever more uncomfortable with the power of science and technology to undermine or even destroy that ecological independence" (p. 8). In a commencement address given to Scripps College in 1962, she spoke of the disruption to natural systems that had achieved balance only over geological time, saying:

I clearly remember the days before Hiroshima I used to wonder whether nature—nature in the broadest context of the word—actually needed protection from man. Surely the sea was inviolate and forever beyond man's power to change it. Surely the sea was inviolate and forever beyond man's power to change it. Surely the vast cycles by which water is drawn up into the clouds to return again to the earth could never be touched. And just as surely the vast tides of life—the migrating birds—would continue to ebb and flow over the continents, making the passage of the seasons.

But I was wrong. Even these things, that seemed to belong to the eternal; verities, are not only threatened but have already felt the destroying hand of man. (Carson & Gartner, 1962/1983, p. 313)

Sustainability Ethics toward Science and Technology

Carson went on to say that, “the age of technology, in which if we should know *how* to do something, we do it without pausing to inquire whether we *should*” (Carson & Gartner, 1962/1983). Many of the scientific discoveries in chemical and nuclear warfare during World War II (WWII), that should have been discontinued, became new industrial enterprises instead. Chemical combinations in the forms of bleaches, aerosols, dyes, and other chemicals never seen before in the universe, became part of everyday American consumption practically overnight. This was especially true in the federally backed agricultural industry, which used propaganda aimed at American citizens for the production of more and more pest control (Carson, 1962). For example, bomb-making plants were turned into fertilizer stations and nuclear testing spiraled out of control with the US conducting thousands of tests and even destroying entire ecosystems in the Pacific (Wilson, 2006).

In the early 1950s, Carson had set out to write a book on evolution, knowing that an “ecological crisis was brewing and that pesticide poisoning was the major factor” (Lytle, 2007, p. 122). Her main impetus was to show what human ecologists would call the deleterious effects of the *technosphere* on the ecosphere, and how to counter this by elevating (local-global) ecology. She believed that a more informed public could partake in the interface of science and technology with government. To accomplish this, she explored the ecology of both nature and the human body to reveal to the public its “slow poisoning” (Lear, 2008, p. x).

After spending five years becoming an expert in chemistry, she developed a theory that the chemicals now becoming a part of everything we touched was not safe. *Silent Spring* (1962) would initiate a call for more transparency in government and industry, providing the general public with a clear and scientific critique of unchecked

industrialism. Most importantly, for sustainability, she demonstrated the need to link science and ethics in decision-making. Her greater body of work, including her letters and four published books, presents a new ecological vision for holism, focusing on multi-generational environmental problems and risks. This was novel thinking that marked a break from some of the earlier naturalist-conservationist writers, and a transition to “environmentalism.”

Carson and many others that followed saw industry—the source of the problem as infiltrating the production of knowledge, going so far as to list Chemagro, Diamond Black-Leaf Co., Shell Chemical, and Monsanto Chemical as funding much of the important research on entomology (Carson & Lear, 1962/2011). Carson writes that

. . . that whereas wealthy families once were the chief benefactor of the Universities, now industry has taken over this role. Support of education is something that no one quarrels with—but this need not blind us to the fact that research supported by pesticide manufacturers is not likely to be directed at discovering facts indicating unfavorable effects of pesticides. (Carson & Lear, 1962/2011, p. 208)

After her death from cancer in 1964, other systems naturalists carried the torch. During the era of environmentalism, or the “age of ecology,” Carson’s thoughts on science and technology were expanded by thinkers Carson admired such as Barry Commoner (1917-2012), who would take them into the political arena over thirty years after Carson’s death (Carson & Lear, 1963/1998, p. 232; Worster, 1994a). Commoner, like Wilson, also saw an ecologist’s duty as applying scientific and ecological findings to the understanding of the three branches. Although he would not come from such an aesthetic appreciation of nature as Carson, Commoner likewise concluded in *Science and Survival* (1963) that “The age of innocent faith in science and technology may be over”

(p. 14). Like Carson, Commoner was a harsh critic of technological optimism, conveying this message in his seminal work, *The Closing Circle* (1971). “In the eager search for the benefits of modern science and technology we have become enticed into a nearly fatal illusion: that through our machines we have at last escaped from dependence on the natural environment” (Commoner, 1971, p. 8).

After Carson, many scientists came forward to argue that the environmental crisis primarily resulted from the technological advances designed to achieve a more sustainable future. Ecological thinking by this time had fully matured as a discipline, but one increasingly obfuscated by notions of progress (Worster, 1994a). Despite coming from different perspective than Carson, Commoner realized that scientific progress came at previously unforeseen costs. For instance both biologists, contrary to popular opinions of the times, asserted that the world was indeed “warming” and not cooling.

Ecology is Integrative

Alongside the scientific changes during Carson’s time, the philosophical phenomenon called *postmodernism* (1945-?) contained new movements such as *environmental justice* and questioned preservationist stances as privileged, while movements like *deep ecology* and *ecofeminism* questioned scientific objectivity. E. O. Wilson, however, has avoided terms like sustainability, environmental justice, and deep ecology, and “all the isms and cynicisms that rode in the wake of WW II and informed the struggle to rebuild human decency from the ashes of the Holocaust” (Gould, 1997, p. 4).

Wilson has, instead, forwarded his own transdisciplinary theories of *sociobiology* (1975), *biophilia* (1983), *conservation biology* (1987), and *consilience* (1998), making this knowledge publicly palatable in his many books of varying reading levels as well as textbooks that have become mainstream in biological and scientific education. Each of

these concepts takes place at the interface of ecological and social studies. Thus, I posit that in understanding Wilson's many works, which have a solid foundation in the scientific method and modern synthesis, he retains the core message of deep ecology—simple reverence for all living things can lead to solving most of our problems.

Wilson (1998) believes the modern synthesis of chemistry, biology, and molecular physics and astrophysics can provide a link for melding the disparate fields of physical science, social science, and the humanities. Over his many years as a biologist, myrmecologist, geologist, and student of social and evolutionary theory, Wilson has devised an environmental platform that incorporates ideals of deep ecology, the humility toward human knowledge, the power of ecofeminism, and the practical applications and greater issues of humanity just now being discerned in the larger sustainability discourse. As demonstrated in his book *Consilience: the Unity of Knowledge*, Wilson (1998) realizes that cultural changes manifested in the social sciences, economics, philosophy, ethics, and the arts are equally as important during the postmodern era of the second half of the twentieth century (1950-2000).

As Wilson (1998) puts it, it was soon after the publication of *On the Origin of the Species* in 1859, that education became highly specialized (Klein, 1990), and divorced from the complimentary system of physics and meta-physics which, however flawed, retained the sense of a holistic understanding of knowledge where science and ethics reinforced one another.

Natural Scientists, chastened by such robust objections to the Enlightenment agenda, mostly abandoned the examination of human mental life, yielding to philosophers and poets another century of free play. In fact, the concession turned out to be a healthy decision for the profession of science, because it steered research away from the pitfalls of metaphysics. Throughout the

nineteenth century, knowledge in the physical and biological sciences grew at an exponential rate. At the same time the social sciences—sociology, anthropology, economics, and political theory—newly risen like upstart duchies and earldoms, vied for territory in the space created between the hard sciences and the humanities. The great branches of learning emerged in their present form—natural sciences, social sciences, and humanities—out of the unified Enlightenment vision generated during the seventeenth and eighteenth centuries. (p. 40)

Science and ethics have since been taught as primarily separate fields. And, this practice persists to this day (Minteer, 2011; Norton, 2005; Wilson, 1998). As a biologist, myrmecologist, and systems naturalist, E. O. Wilson (1998; 2002) calls for recoupling the sciences and humanities, especially within the ivory towers of universities. It may seem ironic that the strategy to save the planet offered by scientist (and someone outwardly opposed to most organized religions) of Wilson’s magnitude “begins, as in all human affairs, with ethics” (Wilson, 2002, p. 151). (After reading the first five chapters of this dissertation, we have come to expect this of systems naturalists.) He goes on to say that ethics designed to benefit human populations and sacrifice ecosystems, however noble in appearance, are not likely to support human populations in the long run and create sustainable global systems (Wilson, 2002).

The majority of sustainability scholars believed that the basic principles of ecology should comprise a greater part of our education, and that its basic principles should be taught at a much earlier age to provide new pathways into understanding coupled human-natural systems. The “ecosystem is the fundamental touchstone of sustainability” and what we must always return to (Redman, personal communication, 2014). We “need to teach ecological science from the beginning, we aren’t doing kids any

favors by filling them full of technological advances” (Weiskel personal communication, 2014). Popejoy (personal communication, 2014) also added, “naturalists show us the importance of personal and immediate experience. I would be skeptical about teaching sustainability without that.”

In the *Future of Life* (2002), Wilson transmits explicit instructions for the members of two general camps (recalling conservationists and preservationists at the turn of the twentieth century), whom he simply calls *environmentalists* and *economists* (aka “Earth-first” and “human-first” camps). He sees these opposing forces as representing deeply entrenched worldviews that inhibit the understanding of SES problems. He begins this seminal work by assuming that both economists and environmentalists are interested in preserving life on planet Earth.

He points out that everyone is somewhat of an economist since even most environmentalists enjoy technology, such as electricity, modern plumbing, etc.; and that, “everyone is also an avowed environmentalist. No one says flatly, ‘To hell with nature.’ On the other hand, no one says, ‘Let’s give it all back to nature’” (p. 182). Likewise, “the people-firster likes parks, and the environmentalist rides petroleum-powered vehicles to get there” (Wilson, 2002; p. 152).

This is probably as true now as it was in the late eighteenth and early-to-mid-nineteenth centuries when Thoreau, (1854), Leopold (1949), and Carson (1962) all lamented technological advances in the forms of trains, cars, and other machines that allowed people access to consume natural resources otherwise out of reach. However, Wilson calls the “people-first ethicist” in contrast to the “environmental ethicist” as someone who simply thinks about the short term rather than the long term. His prescription for resolving the two is not as bad as one might expect, suggesting “[1] the

breakup of ideological beliefs and any inherent ‘moral superiority’ attached to them; and [2] disarming” our ideological stances (p. 152).

Wilson (2002) argues that the economist, in defending the green revolution, believes “human ingenuity has always found a way to accommodate rising populations and allow most to prosper. The green revolution, which dramatically raised crop yields in developing countries, is the outstanding example (p. 25).” Likewise, the economist most often cites the fact that the wellbeing of developing countries has risen in direct proportion to its economic growth and use of resources, which is probably why he finds it appealing (Wilson, 2002).

The environmentalist, Wilson’s real champion, instead sees the world as “exhausted” and “depleted,” and that we cannot possibly raise every human member of the Earth to the standard of living in the US. “For every person in the world to reach present U.S. levels of consumption with existing technology would require four more planet Earths” (p. 3). He goes on to say,

If natural resources, particularly fresh water and arable land, continue to diminish at their present per-capita rate, the economic boom will lose steam, in the course of which—and this worries me even if it doesn’t worry you—the effort to enlarge productive land will wipe out a large part of the world’s flora and fauna. (p. 27)

While initially trying to negotiate between them, Wilson finally condemns the economist as fundamentally short sighted and crediting the environmentalist with seeing the long view. Economists, he (2002) writes,

... and most of the rest of us, have yet to learn the arithmetical riddle of the lily pond. A lily pad is placed in a pond. Each day thereafter the pads and all its descendants double. On the thirtieth day the pond is covered completely by lily

pads, which can grow no more. On which day was the pond half full and half empty? The twenty-ninth day. (p. 313)

This means that the emergent ecological characteristics of positive feedback loops and exponential growth or loss within an ecosystem (especially within human dynamics) do not adapt well to continuous economic growth. Wilson (1998) underscores an important social consideration: in 1950, 68 percent of humanity lived in developing countries. In 2000, it is estimated at 78 percent (Wilson, 1998, p. 197). A better standard of living (and thus both human and ecological health and wellbeing) is therefore receding from reach, not expanding.

Wilson (2002) boldly states that in order to protect human welfare, we must preserve *most* of the remaining natural ecosystem. In order to do so, we must put an end to poverty as well as raise human education, health, and the wellbeing of developing countries to give them the foundation and education to clearly see ecological values as the future stewards of biodiversity. Thus, ecological and human preservation become one and the same.

Transdisciplinarity: Discussion and Conclusion

While this dissertation focuses on events that began after the industrial revolution, Wilson (2006) and other anthropologists have argued that the Neolithic Revolution itself is based upon “the false assumption that a tiny selection of plants and animals can support human expansion indefinitely” (p. 11). Prior to Wilson, many thinkers described an apocalyptic scene brought on by human activities, not unlike popular movies today that foresee the end of a plentiful ecosphere. In the beginning of *Silent Spring* (1962), for example, Carson writes: “The roadsides, once so attractive, were now lined with browned and withered vegetation as though swept by fire. ... No

witchcraft, no enemy action had silenced the rebirth of new life in this stricken world. The people had done it themselves” (p. 3).

Capitalists, industrialists, and bureaucrats, all of whom wanted a tighter control over public behavior, attacked Carson’s (1962) work. Though it might have been difficult to see at the time, more than 50 years after the publication of *Silent Spring* it is easy to see the general thesis was correct. After Carson’s book, many other scientists from an array of fields came forward (Lytle, 2009). Likewise, Wilson’s perspective on Western society’s destruction of the environment is 20/20. Not stopping there, Wilson tries to untangle anthro- and eco-considerations, as they apply to human groups, to uncover what actions that can benefit one can also benefit the other.

This anthro- / nonanthro-polarity is reflected in the word environmentalism itself, which to be truly understood must encompass mastery from many different fields. As E.O. Wilson argues in *Consilience* (1998), these principles can only be derived through the integration of fields and seeing what they have in common.

What is the relation between science and the humanities, and how is it important to human welfare? Every public intellectual and political leader should be able to answer that question . . . Most of the issues that vex humanity daily—ethnic conflict, arms escalation, overpopulation, abortion, environment, endemic poverty, to cite several most persistently before us—cannot be solved without integrating knowledge from the natural sciences with that of the social sciences and humanities. Only fluency across the boundaries will provide a clear view of the world as it really is, not as seen through the lens of ideologies and religious dogmas or commanded by myopic response to immediate need. (p. 13)

Wilson (1998; 2002), like Leopold and Thoreau, has commented that only ethics will save us. Moreover, Wilson (1998) advocates that we are capable of living we are fine

with the existing technology we have now. At the end of each of their books, both Carson (1962) and Wilson (1998) discuss making the right technological choices and following the right path with the wise use of technology, which can only be understood from outside the sciences in the realm of ethics. While Wilson (1998; 2006; 2012) often hails the miracles of science as evidence of a higher order, he also tempers such sentiments with a human and natural philosophy based on precaution and logic. “It is too early to speak seriously of ultimate goals, such as green-belted cities and robot expeditions to the nearest stars. It is enough to get *Homo sapiens* settled down and happy before we wreck the planet” (p. 325).

Norton (2014), who acknowledged that he had not carefully read *Consilience: the Unity of Knowledge* (1998), questioned Wilson’s (and others’) reductionist form of positivism, holding that society, like the physical world, operates according to general laws. He emphasized the definition in the *Oxford Online Dictionary* that states “. . . every rationally justifiable assertion can be scientifically verified or is capable of logical or mathematical proof, and that therefore rejects metaphysics and theism” (Oxford, 2014). Norton (2014) has this problem with the term *sustainability science* as well, saying it “creates a value-neutral description of the world, while what we need is a post-positivist assessment of environmental problems.”

Wilson (1998) recognizes the importance of being “happy” and centers educational aspirations on human and ecological “wellbeing” (pp. 325). While basing sustainability on human and ecological welfare seems like common sense to many, systems naturalists often employ the protection of cultural places to rally biological protection in order to preserve social systems.

Many of the sustainability scholars interviewed said the university system needs major reform. As Peter Byck (2014) said “silo-busting” is the common term for it, and

the idea has been around a long time. He suggested, along with Redman (2014), that a differing reward structure is needed as an alternative to the current system that rewards increasingly specific levels of disciplinarity. When I interjected that there need to be generalists in academia whose job it is bring people together, this kind of “cross-fertilization,” Byck (2014) argued, needs to be taken outside of the four walls. “In the field” has been taken to be figurative for too long and should now be taken literally (Byck, personal communication, 2014).

Ecological fieldwork and scientific uncertainties also provide evidence that the idea that science is supreme is a myth. “‘Techno-boomerism’ and ‘Tinker Bell science’ like that promoted by Walt Disney in the 1950s has dominated contemporary science, instead of asking, ‘how do we adjust into the system we’re born into?’ which is a much more scientific question” (Weiskel, personal communication, 2014),

There was some disagreement among sustainability scholars interviewed about whether ecologists should be at the center or merely part of sustainability. Suggestions included that we need to initiate ecology and biology as the core of science earlier in elementary school (Bill, Weiskel, personal communication, 2014); that “ecologists should be paired with sociologists” (Santone, personal communication, 2013); and that the most important element involved the scientific value of being “open-minded” (Bill, personal communication, 2014). Regardless, system naturalists were recognized primarily as environmentalists who can address the big picture in the ecological and environmental sphere. But before applying the principles of systems naturalists to sustainability coursework, in the next chapter, I briefly summarize the findings of this dissertation.

CHAPTER 11: A SYSTEMS NATURALIST CURRICULUM

Most sustainability scholars I interviewed believed system naturalist principles should be *both* part of, *and* integrative with, traditional sustainability courses. Yet moving beyond this general principle to the actual implementation of a curriculum enhanced with system naturalists ideas remains a challenge. As Redman (personal communication, 2014) points out, “interdisciplinary metrics are not well worked out.” However, some seemed to think that there was appreciable integration among sustainability scholars, especially from the literature they had read from ASU faculty, and the School of Sustainability’s mission encouraged them.

The following discussion on sustainability education will aid in answering the question: *How can we operationalize naturalist thinking in sustainability education to make it more integrative, transformative and ecologically based?* Because sustainability is a multi-generational challenge, sustainability education should look to the past—our only reservoir of knowledge available that is proportionate to the size and range of a civilization that will endure indefinitely.

The core curriculum coursework I describe here can give students the idea of coupled systems, the relationship between economics and ecology, and transdisciplinary concepts values and principles. This coursework can be applied as (a.) part of a capstone project for an undergraduate major in sustainability, (b.) core courses of an introductory sustainability graduate major, or (c.) as supplementary courses to a program that lacks education on the history of proto- ecological, coupled systems, and sustainability concepts, values, and principles.

As discussed in the previous section, sustainability thinking has typically compartmentalized knowledge that is not connected to the whole. For starters, it has failed to ground itself in the idea of “liv[ing] off nature’s interest, not its capital”

(Cortese, 2003, p. 19). Moreover, sustainable education that is not based on normative sustainability (Norton, 2005) falls short of what is required to preserve the life forms of the planet, and guide sustainability education centered on SES problem solving.

Sustainability education must be about real-world problems in a normative sustainability framework, based on ecological integrity, societal integrity, and socio-ecological resilience (Norton, 2005). In this discussion about sustainability educational theory, I focus on real sustainability problems facing both ancient and present societies and the thinkers who explored knowledge and values in the three overlapping proto-sustainability theory, applying theory to practice, and educational theory.

On the core issue of when and what tradeoffs are appropriate, however, sustainability scholars often differed on the degree of the crisis and the level of preservation. For example, Weiskel (2014) stated, “Naturalists can address the problem because at its core the problem is fairly simple.” Redman (2014) was more cautious, “I wouldn’t turn it over to [the naturalists and ecologists],” he said, “Ecology often translates poorly to social science . . . ecologists make a series of sub-assumptions that social scientists can’t.” How can we design a sustainability curriculum that includes systems naturalists’ principles?

This chapter will first review recent sustainability pedagogy, explore competencies, and finally design a framework and syllabus to augment existing sustainability programs, or provide the core classes for a more transformative sustainability education based on three areas:

- i.) reading natural and cultural histories together;
- ii.) uniting sustainability theory and practice; and
- iii.) uniting the three branches (natural sciences, social sciences and humanities).

In addition to the literature in Chapters 1-6, I focus on the distinction in higher learning between sustainability, *education for sustainable development* (ESD), and *education for sustainability* (EfS). In the short literature review next, I discuss these differences before going on to explain my curriculum for sustainability (EfS).

Previous EfS and ESD Pedagogy Studies

In this short discussion, I further explore sustainability and sustainable development pedagogy in order to not only examine how sustainability has generally been taught, but also to assert transformative frameworks that are more in accordance with the range, scope, and depth of systems naturalist writing. In sustainability pedagogy literature, there seems to be a large—however blurred—distinction in sustainability and sustainability development education (Pijawka, 2015; Reid & Petocz, 2006; Thomas, 2009). First, education for sustainable development (ESD) is centered on “conflicts that emerge” in actual cases of sustainable development and tensions that stem from conflicts among the three pillars of the Brundtland E’s (Efficiency, Environment, Equity) and the three P’s (People, Planet, Profit) (Wals, 2006, p. 103).

In ESD, UN literature is the guiding force behind the formation of higher education. Core to this is the United Nations Educational, Scientific and Cultural Organization’s (UNESCO) pre-eminent guide for higher education in sustainability, “The Drivers and Barriers for Implementing Sustainable Development in Higher Education.” It is also often partnered with the Organisation for Economic Co-operation and Development (OECD), which does not emphasize environmental values nor ecosystem loss, in its definition for “sustainable development” (OECD, 2014). The Göteborg Workshop written from the presentations on December 7-9, 2005 may be the most often referred to, but of its 14 articles, none emphasize the natural environment or ecology, or

even devote a third of the discussion to this area, as the three pillars seem to recommend.

To give ESD programs the benefit of the doubt, the degree of ESD depends considerably on the school's historical orientation. The Open University of the Netherlands' implicit ecological focus on "System Earth" from the domains of geology, biology, chemistry, physics and mathematics, for instance, probably provides a more balanced socio-ecological perspective than an ESD program in a business school (p. 16). Moreover ESD and EfS (i.e., Education for Sustainability), have common themes like the use of sustainability competencies, team building, and community outreach. They also agree that disciplinary tracts are not commensurate with the magnitude of future challenges. For example, UNESCO's (2009) lengthy Göteborg document states explicitly that "a certain amount of disciplinary oriented teaching will remain useful in the future as well, but for dealing with societal complexity that will not be sufficient" (p. 15). Other ESD statements that systems naturalists and coupled systems thinkers could agree with (though not well articulated in the reports themselves) was evident in their opening statement at Göteborg, when UNESCO took a long-term view, "Sustainable development and social cohesion depend critically on the competencies of all of our population—with competencies understood to cover knowledge, skills, attitudes and values" (OECD, 2001, p. 4). Even in ESD literature, sustainability educators have expressed the need for a new framework, accompanied by alternative thinking (Wals, 2006).

ESD is designed to investigate the "system in which we live" (Colucci et al., 2006, p. 16). In fact, one of the most lucid statements about what sustainability at the university should do comes from ESD literature:

In order to fulfil [sic] their outreach/service function at regional, national and international levels as well, universities and higher educational institutes will

have to be active nodes in international/national/regional networks with other partners such as primary and secondary schools, vocational education, science centres [sic], small and medium sized companies, chambers of commerce, NGOs [non-governmental organizations], national and regional governments, etc. (Göteborg , 2006, P. 12)

Education for sustainability (Efs) literature has arguably many of these exact same goals.

In reality, however, there are large gaps between ESD and Efs education. Efs contrary to ESD, has a stated focus on transformative “curriculum change” (Mudler & Jansen, 2006, p. 72). Implicit in Efs is the elevation of the goal of transformative pedagogy (Jickling & Walls; Sterling, 2004; Wiek & Redman, 2012), “transformative living” (Wals, 2006, p. 163), and a “holistic” and “transformative experience” within the community (Pugh, 2010, p. 204). In examining this argument, Jickling & Wals (2008) write that “globalization refers to the rise of economic ideologies embodied by the corporate sector and to the erosion of grassroots democracy” (p. 14).

Unlike these ESD frameworks directed at partnering with big money institutions of government and private interest in science and engineering-based projects, Efs frameworks include the goal of mobilizing “grassroots movements” and incorporating their “creativity” to form a much more active and “educated citizenry capable of “critical thinking” (Thomas, 2009, p. 256-7). Thomas (2009) has expressed that Efs, as opposed to ESD, centers on “Strong values base to allow for connectivity of self with community; sustainability values include: compassion, equity, justice, peace, cultural sensitivity, respect for the environment, and recognition of the rights of future generations” (p. 256).

Most distinctive yet is Efs’s stated primacy of environmental health and wellbeing. As I have mentioned previously, Robert Kates has argued for not only social and technological but also biological and geological interests in the macro sense of global

challenges. This is notably so as SES is “problem driven” (Kates & Clark, 1999, p. 1) and a number of fields are necessary for addressing *wicked problems* (Kates & NRC, 1999; Kates & Parris, 2003; Kates, Travis & Wilbanks, 2011). As Wiek and Redman (2013) argue, solving these problems should be not only the goal of EfS, but also the goal of society at large, extending the EfS mission far beyond the walls of the university. In this dissertation, I have demonstrated how my thoughts concur with Thomas (2009), who also says, that while this may “appear new,” environmental management and other coursework is intertwined with a long history of “pro-localism, anti-consumerism, anti-genetically modified food and critical of globalisation” (p. 255)

In writing a sustainability curriculum, I draw largely from the discussion above, as well as my experiences as either student or as teaching assistant in three comprehensive EfS core courses in undergraduate, masters, and doctorate programs at the Harvard Extension School and the Arizona State University School of Sustainability. I also worked broadly with urban planners and indicator-based sustainability as well as authors of Boston and Phoenix Sustainability and Climate Action Plans (Thomas, 2012).

Sustainability Competencies and Goals

The need for sustainability education (EfS) is widely accepted as a process-related pedagogy involving team building, Problem-Based Learning (PBL), contextual problem-solving, and transformative theory, practices and education through innovation and creativity (Thomas, 2009). Transdisciplinary problem solving, in particular, traverses from theory to practice, unites disciplinary perspectives, and relies on community and team-building skills that extends outside the university; this approach is what is required to solve today’s SES problems (Klein, 1990; 2006). For example, Arizona State University President Michael Crow has made it the University’s mission to

produce “a new generation of leaders through collaborative, transdisciplinary and problem oriented training” (Crow, 2012). Under the President Crow’s guidance, ASU has implemented eight aspirations (one of which has been to “fuse disciplines”) and designated the School of Sustainability as the premier place that this kind of sustainability discourse should occur ubiquitously.

Many sustainability scholars interviewed did not offer viable mechanisms regarding how to incorporate the naturalists into sustainability education. Several have suggested the reform efforts at ASU led by President Michael Crow was accomplishing this, while others believed that the lack of deep thinking about this question makes it challenging to design a curriculum around sustainability that includes contributions from every discipline (Klein, Rudy, Santone, personal communication, 2013-14). Those who were familiar with ASU’s School of Sustainability program seemed to have faith that the courses offered through this program could provide these interdisciplinary pathways and expressed admiration for President Crow’s efforts.

This mission and support from the administration has facilitated transforming traditional environmental and planning education and are capable of incorporating systems naturalists into sustainability education. An EfS curriculum should enable the incorporation of many of the values of sustainability—social, cultural, ecological, scientific, aesthetic, and economic—into the core curriculums and encourages undergraduates to use these multiple values and their creativity to help resolve real-world sustainability problems through the lens of restoring, enhancing, and building-up the natural systems in cities.

During the fall of 2012, I designed, and began implementing, a transdisciplinary curriculum framework comprised of twelve competencies that relied on teachings from the four historical naturalists and humanists (Henry David Thoreau, Aldo Leopold,

Rachel Carson and Edward O. Wilson) and in accordance with the body of transdisciplinary literature (Brown, Harris & Russell, 2010; Klein, 1990; 2006; Wiek, 2007; Wiek & Redman, 2012; Wilson, 1998). The competencies include:

- Future SES-problem orientation (as opposed to “use-inspired research” (Crow, 2004))
- Primacy to qualitative methods to develop orientation
- “Normative science” (Norton, 2005)
- Contextual thinking
- “Socio-ecological systems” (SES)-thinking (Colucci et al., 2006)
- Utilizing existing technologies (rather than creating new ones)
- Communicating among disciplines & practitioners (Wilson)
- Distributed intelligence and life-long learning
- “Real-world” problem-solving (and “Need-based”) (Brundiers, Wiek, & Redman, 2010)
- Community-based, including cultural restoration and preservation (Wilson, 2002)
- Ecological integrity for global carrying capacity
- Elicit “community’s passion” and “engaging whole self” (Beatley, 2009; Sipos et al., 2008)

Transdisciplinarity is still a relatively young field, which continues formulating learning outcomes (Frederick & Pijawka, 2015). Wiek, Withycombe, and Redman (2011) have developed four categories of systems thinking—anticipatory, normative, strategic, and interpersonal competencies—that act as a guide for sustainability education. But such a framework may be overwhelming, as just finding a common vocabulary can be difficult (Frederick & Pijawka, 2015, p. 279). Outcomes, however, need not always be the

driving force of an Efs class as courses may be considered “a process, not an outcome” (Thomas, 2015, p. 256).

Core Sustainability Coursework

As part of core sustainability coursework (SES-501; SES-502), student groups take on research within communities and work on specified problem areas regarding natural systems. Their group project provides guidance on how to conduct research, work effectively in groups, and connect with communities. The underlying goal of each of these facets is to approach the assignments from a transdisciplinary approach to learning through a set of tasks:

- Read and understand SES challenges and changes through history
- Recognize how knowledge and human activity often fail to support one another
- Focus on a specific sustainability and/or socio-ecological system (SES) problem, and develop a specific, multi-scaled policy through project work
- Engage in community interviews and surveys (e.g., local, national, regional, global community)
- Collaborate in a group setting
- Engage in self-directed learning in which students take more responsibility for determining what they need to learn and do to develop project output.
- Meet with instructors, who coach students’ self-directed efforts.
- Learn through real-world experiences (teamwork, community outreach, collaboration, presentation).

Students should be given lots of freedom and considerable responsibility. The project requires them to work in teams, interact with contacts and stakeholders at their research sites, design and conduct research, and develop recommendations for future

research or intervention at their research site. Designed to help students develop key competencies in sustainability, transdisciplinarity, and SES problem solving, this approach enables them to tackle some of the largest SES problems in their local, regional, national, or global community. As a result, students develop basic knowledge, skills, and attitudes essential for collaboration (interpersonal competence), sustainability problem identification (systems thinking competence), indicator selection and assessment (normative competence), and project work (strategic competence) at an introductory undergraduate level. Instructors provide one-on-one instruction during recitation classes and appointments, and graduate-level instruction on researching tools at ASU.

In efforts to raise collaboration awareness, students should be provided with supplemental resources including Team Code of Cooperation and Stakeholder Engagement Guidelines as well as Project Work Plan and Meeting Agenda templates. Instructors can rely on multiple data sources, including instructors from over ten different departments, outside experts, websites, videos, and online lectures. Instructors also arranged to provide students with group meeting times, one-on-one attention when needed, and for groups to meet frequently during class sessions to work on their team-based projects.

Objectives

This core sustainability curriculum is designed as a two-semester course but could be taught in one semester, by abbreviating the readings and questions designated for each unit. Each student is required to understand the *key concepts* of each unit and prepare for class lectures and breakout group discussions by writing about their *journal questions*. In addition to a midterm and final that cover the class readings, students work on a class project that demands group work (including choosing a leader and assigning

tasks) as well as approaching a specific SES problem on at least two scales (e.g., local and regional, regional and national, or national and international) and designing a single policy aimed at making those areas more sustainable. Recommended projects are available to the students in order to immediately link students to real-world, on-the-ground projects in the global community, at the home university, or both. A *midterm exam*, a *final exam*, *peer evaluations*, *group grade*, and *weekly quizzes* that track attendance, provide measurable results for the student's grade.

Units

In designing this course, I took a challenge-response-challenge approach as discussed by Worster (1985) as an introduction to sustainability knowledge and values across socio-ecological systems and diverse disciplines. Each of the ten units provide literature as either a response or challenge point-of-view for examining the relationship between people and nature through many different historical, geological, chemical, physical, economic, cultural, and ethical horizons of interpretation.

For example in "Unit 1: The Challenge of Past Societies and Dark Ages," I discuss how various threads of changing climates, local soil, forest, and agricultural homogenization contributed to the "fall" of societies such as the Acadian, Greek, Roman, Khmer, and Norse civilizations, often previously attributed solely to war. In the following "Unit 2: The Response of Empire and Enlightenment Thinking," I discuss how Enlightenment thinkers, well-aware of coming out of a dark age, integrated the teachings of past civilization into a Christian and hierarchical framework that placed human beings at the center of the universe, and subsumed the role of natural systems as one designed for the consumption of human beings alone.

Framework

If one of the major appeals of the *Brundtland Report* (1987) was a manageable “three E’s” that people from all occupations and perspectives could appreciate and remember, I propose a transdisciplinary framework based on three holistic and defining characteristics of systems naturalists and the that constitute the organization of this dissertation, which I believe to be comprehensive areas of the sustainability paradigm (see Figure G).

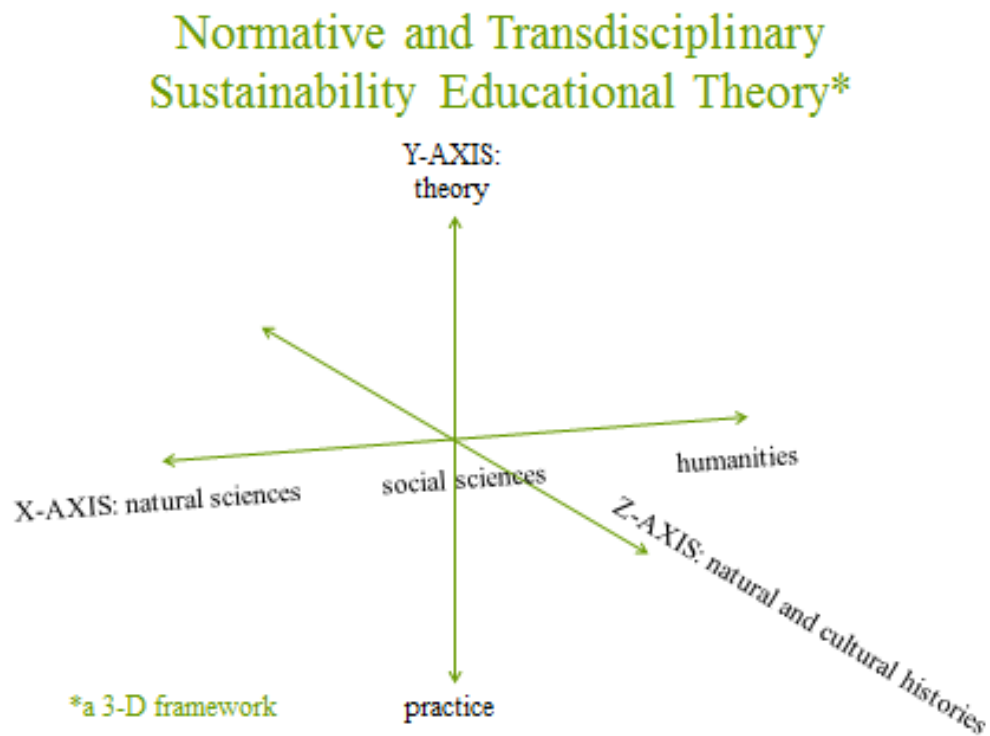


Figure G. A Three-Dimensional Framework for Sustainability. An SES problem-solving and transdisciplinarity approach provided by naturalists.

1. *Unite the three branches (natural sciences, social sciences and humanities). The four naturalists systematically relate to the greater whole of academic discourse across sciences, social sciences, and humanities through holistic thinking. Inductive reasoning integrates academic theory to on-the-ground observations.*

2. *Unite theory and practice (y-axis)*. Through direct observation and experimentation, and deep understanding of theories across epistemologies, naturalists provide the link between application and discourse.
3. *Read natural and cultural histories together (z-axis)*. Geological and ecological history supplements cultural history, to inform, enhance, and sometimes contradict it. This provides depth and a more nuanced view of sustainability and SES problems.

A Systems Naturalist Syllabus

In this course in the history of sustainability discourse we study sustainability, coupled systems, and transdisciplinarity through the lenses of our cultural and natural histories. Through our social and environmental history, we will explore how to contextualize today's largest sustainability challenges, particularly through the work of naturalists, our first scientists, who will be present in each unit. We will investigate why cultural and environmental studies must be synthesized to address socio-ecological system (SES) problems for the long-term survival of planetary life, and how systems-naturalists provide a holistic framework for approaching these problems.

Grading

Midterm Exam (20%)

Multiple choice. Based on key words from Units 1-5.

Final Exam (20%)

Multiple choice. Based on key words from Units 6-10.

Weekly Single-question Quizzes (10%)

Based on the readings of the unit to that day, it should be easy for students to receive 100% on each quiz if they have read the article and are in class. All readings are

included in the required texts, or available online. It is imperative to attend to be successful in this class.

Journal Entries (10%)

Journals will be handed in at the end of each unit and returned at the end of the following class. Journal entries should be 1-2 single-spaced pages, with no spelling or grammar errors, and written to APA format. Poorly written journal entries will not be graded, but can be rewritten within one week of receiving grade. Some journal questions are given initially, but eventually journal entries should take their own direction.

Peer Evaluations (10%)

Peers will submit peer evaluation grades three times throughout the semester, to help identify problems in team building. Instructor will moderate to ensure fairness. Leadership and other positions will be assigned during the first unit, so that the expectations of each position are clear.

Group Project: (30%)

A 10-20 page, graduate-level term paper, and an accompanying 30-45 minute oral presentation: Each group will design a project that addresses local-to-global SES (socio-ecological system) problems such as global climate change, biodiversity loss, or rising consumption (i.e., if the focus is a local climate change problem, how your solution scales up to the global level; if the focus is global population growth and consumption, how your solution will change local consumption rates). The purpose of the project is not only to become involved in local, state, regional, and global communities but also to develop practical applications to the sustainability, coupled-systems, and transdisciplinary competencies learned. Project leaders must make an appointment and meet with me twice during the semester, prior to their project presentation. Group members are welcome to attend.

In particular, Students will examine the ideas, concepts, and principles of American naturalists, in order to see how naturalist thinking can make an area or areas of a city not only more “biophilic,” but more “sustainable.” Group work will address a sustainability and SES problems over the long term in one designated area, asking how would American naturalists like Henry David Thoreau, Aldo Leopold, Rachel Carson, or E.O. Wilson look at this particular sustainability problem, using the competencies of transdisciplinary theory (e.g., system-thinking, connecting academic theories to real-life problems and solutions, community building over the long term, etc.) highlighting the thinking of a particular naturalist. Assuming these authors can provide a basis for transdisciplinary thinking, the student will design an intervention based on long-term sustainability principles in their area , keeping the following questions in mind:

- *To what degree is your socio-ecological problem (i.e., wicked problem) the same or different from a traditional, single-discipline conservation problem?*
- *Are the biggest needs for the solution social, economic, scientific? Educational, economic, or ethical, etc.? Collectively what disciplines must be understood in order to address both the problem and the resolution?*
- *What is the natural history of the area? How have the natural history and the cultural history of your area coevolved to make this place unique? How will this unique context affect how we approach the problem?*
- *How can you elicit expertise and mastery for mutual community benefits?*
- *How can you integrate transdisciplinary education to connect institutions with the community?*
- *What are the potential future challenges five years down the road? 50 years? 100 years? Could your area’s ecosystem be very different then from now?*

- *What would the future environment look like without addressing your chosen problems? How would it look different without your resolution? What is your group's vision for the future?*
- *Can you capitalize upon existing technologies? How can we elicit historical, cultural and ethical values that inspire community monitoring and reporting?*
- *How would traditional naturalists from each unit approach today's largest and global SES problems?*

Course Structure

Unit 1: Past Societies and Dark Ages

Key concepts: dark age, empire, Aristotle, Easter Island, Platonic thought, idealism, forms, industrialism, scientific and environmental management.

Week 1: Watch "Collapse" Ted Talk Jared Diamond; Read Plato's "Allegory of the Cave"; Aristotle's *Physics: Book 1*.

Week 2: Stephen Mosley's (2010) *The Environment in World History*.

Journal Questions: Why did former societies collapse? "Dark ages are instructive because they are extreme examples of cultural collapse because they are more extreme and clear-cut and vivid with gradual delay" (Jacobs, 2004); what do they teach? How did the health and integrity of the natural world change during the Agricultural Revolution? During the Age of Conquest? During Industrialism? After World War II? During the embracing of globalization in the last part of the twentieth century? During the first part of the 21st century? How did Western culture change during these periods?

Unit 2: Empire and Enlightenment Thought.

Key concepts: the scientific method, deductive reasoning, inductive reasoning, Linnaeus, taxonomy, Descartes, the Cartesian split, Buffon, natural philosophy, metaphysics, the natural sciences, the humanities, consilience.

Week 1: Stanford Encyclopedia of Philosophy ““The Concept of Evolution to 1872” <http://plato.stanford.edu/entries/evolution-to-1872/>; “Rene Descartes” <http://plato.stanford.edu/entries/descartes/>.

Week 2: Edward O. Wilson’s *Consilience. The Unity of All Knowledge*. Chapters 1-6.

Journal Questions: How would you describe the human/nature relationship during the Enlightenment? How did conquest fuel the expanding European empire? How did competing cultures react? What is the legacy of the Enlightenment and Age of Empire in the Western world today?

Unit 3: American Industrialism, Expansionism, and Exceptionalism.

Key concepts: the three branches, the two cultures, the spread of industrialism, the Midwest, Manifest destiny, the West, invasive species, the Homestead Act, the Trail of Tears, globalization.

Week 1: Donald Worster ‘s (1990) “Transformations of the Earth,” *The Journal of American History*; (1987) “The Vulnerable Earth: Toward A Planetary History.”

Week 2: William Paley (1802) *Natural Theology* “Chapter XXV: The Unity of the Deity”; Henry David Thoreau *Walden or Life in the Woods:*” Economy.”

Journal Questions: How does Worster interpret the effect of the settlement of the American West on its natural environment? Industrialism? Compare and contrast Paley’s views on “nature,” “God,” and “duty” with Thoreau’s. Why can’t social problems be separated from environmental problems? What are the benefits and costs of globalization? How was the treatment of Native Americans unsustainable?

Unit 4: Darwin and Conservation during the Progressive Era

Key concepts: conservation, preservation, Hetch Hetchy, maximum sustainable yield (restoration?), environmental management, scientific management, ecological science, the “Dust Bowl,” environmental refugees.

Week 1: Paul Farber (2000), *Finding Order in Nature. The Naturalist Tradition from Linnaeus to E. O. Wilson.*

Week 2: John Muir’s (1912) *The Yosemite*: Chapter 16: Hetch Hetchy Valley; Aldo Leopold’s “*The Land Ethic*,” “*Wilderness*,” and “*The Conservation Esthetic*.”

Journal Questions: How did Darwin’s discovery affect other areas of knowledge? Science? Ecology? Economics? How did the settlement of the West (e.g. The Homestead Act s) affect the human nature relationship? How did Federal policies contribute to the Dust Bowl of the 1930s? What would have been a more sustainable way to settle, or not “settle,” the west? Compare and contrast Muir’s and Leopold’s values, rhetoric, principles, and understanding of the life sciences.

Unit 5: The Post-WWII settlement

Key concepts: The five stages of development, The UNCHE, “Small is Beautiful,” the toxic discourse, transdisciplinary, postmodern, non-anthropocentric, anthropocentric, globalization, wicked problems.

Week 1: Rachel Carson (1962). *Silent Spring*

Week 2: Michael Foucault (1975). *The Order of Things: An Archeology of the Human Sciences*. “Chapter 5. Classifying,” and “Chapter 6: Exchanging”

Journal Questions: How is Carson’s book transdisciplinary? Be able to describe the causes and consequences of industrial production on land, air, ocean, soil, groundwater systems to nature and society. This era includes the laying of the national interstates, the ramps up of industrialization, the adaption of war products to new

consumer products like bleaches dyes and insecticides; how did these changes in production and consumption affect the worldview of the typical American?

Unit 6: The Environmental Movement and Social Activism

Key concepts: postmodernism, The Frankfurt School, quantum physics, post-structuralism, cultural theory, orientalism, post-colonialism, the *Limits to Growth*, the *World Conservation Strategy*, resiliency, the *Brundtland Report*.

Week 1: Phillip Smith's *Cultural Theory: An Introduction*. Chapters 1-7

Week 2: Familiarize yourself with the *Limits to Growth* (1972), and the *World Conservation Strategy* (1980); and the *Brundtland Report* (1987).

Journal Questions: How did philosophical, and philosophy of science movements adapt to the changes in western society following World War II? How did the international development discourse begin to integrate with environmental discourses? What were some of the outcomes? Why is an understanding of ecological limits crucial to interpreting global economics? How did the *World Conservation Strategy* frame sustainable development? How does the *Brundtland Report* frame the role of women? What is the role of the humanities in making complex scientific and ecological issues accessible to the general public?

Unit 7: The Disaster Discourse, and Developing vs. Developed Worlds.

Key concepts: toxic discourse, wicked problems, ecosystem regimes, Kates and Pijawka recovery phases, Lois Gibbs, Three Mile Island, industrial agriculture, Strontium, FDA, Commoner group, Clean Air and Water Acts, RECA.

Week 1: C.S. Holling's (1969) *Stability in ecological and social systems*; and (1973). *Resilience and stability of ecological systems*.

Week 2: Jeffery Baumgarner's (2008) *Emergency Management*, Chapters 1-5.

Journal Questions: How did the change in worldview in the 1960s and 1970s effect the environment? How did the inherited Enlightenment paradigm affect social, natural and economic systems in the twentieth century? How did things change, or not change, in in the United States during the 1980s and 1990s?

Unit 8: Deep ecology, Biodiversity, Environmental Justice

Key concepts: bio-ecocentrism, eco-sphere, techno-sphere, environmental justice, deep ecology, Barry Commoner, bioregionalism, eco-feminism, the end of nature, the death of nature, Chester, Pennsylvania.

Week 1: Arjun Appadurai, “Globalization.” Luke Cole’s and Sheila Foster’s *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement*. Chapters 1-4.

Week 2: Daniel Quinn’s (1995), *Ishmael: An Adventure of the Mind and Spirit*.

Journal Questions: How does a non-anthropocentric (aka bio-centric or eco-centric) worldview differ from and instrumental and anthropocentric worldview? Compare and contrast bio-regionalism, deep ecology and eco-feminism. How has this worldview helped or hinder past sustainability discourse? Is it important to future sustainability discourse? Previously we discussed Leopold’s idea of how a leaf can be a book? How can a gorilla teach us our natural and cultural history? Compare and contrast the idea of a “natural history of culture,” versus a “cultural history of nature?” How is each important? How is each incomplete?

Unit 9: Post-colonialism, Globalization, and Second Nature

Key concepts: post-colonialism, globalization externalities, sustainability SES problems, sustainability science, SD, ESD, EfS, *environmental pragmatism*.

Week 1: Wilson *Consilience*. Chapters 6-12; Kates & National Research Council (NRC). (1999). *Our Common Journey*; Kates et al. (2000) “Sustainability science”; and Kates & Parris (2003). “Science and technology for sustainable development.”

Week 2: Vandana Shiva’s (2001) *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology*.

Journal Questions: How is science and technology important to sustainability or sustainable development? How can they be detrimental to long-term sustainability? How is sustainability science different from sustainability? What else is important to long-term sustainability besides understanding the science of SES problems? What is Shiva’s sustainable development strategy for the Global South? Why is the role of women in the Global South critical to sustainable development? How does the current rapid transfer of technology to the Global South endanger its ecology? Its agriculture? Its culture?

Unit 10: Coupled Systems Theory, Resilience Theory and Transdisciplinarity

Key concepts: IPCC, carbon footprint, ecological footprint, sustainability science, CHANS, adaptive capacity, ecological economics, biodiversity loss, regime change, peer review.

Week 1: Brian Walker’s and David Salt’s (2006) *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*.

Week 2: Familiarize yourself with the World Wilderness Congress Report (2014); IPCC (2014) Report.

Journal Questions: Be able to describe three examples of large scale systemic change for sustainability? Also be able to describe top-down versus bottom-up planning in these examples. Compare and contrast sustainability theory learned this semester with resiliency theory? How does the level of peer review in the IPCC and the WWCR

compare with other historical scientific studies? Do they fully utilize the scientific method? What are the political issues? How have these political issues been shaped by the media?

A Systems Naturalist Curriculum: Conclusion

In search of lessons on sustainability, this dissertation has explored ideas, concepts, and values from an array of historical areas including Ancient Greece, Enlightenment Europe, and America during the Industrial Revolution, Progressive Era, and post-WWII eras. It has found that systems naturalist principles are holistic and ecologically grounded, and uniquely equipped to guide the sustainability paradigm, practices, and pedagogy in the twenty-first century. *Walden* began the investigation of the integration of science and philosophy to tackle the problem of how to live in an industrializing world that simultaneously alienated people and nature. *A Sand County Almanac* elevated the importance of biological integrity beyond species we normally judge as valuable and created a framework based on socio-ecological resistance. *Silent Spring* was a wake-up call to look at the full lifecycle of products that cradle-to-grave had repercussions around the globe and had nearly unimaginable costs to both society and nature. Finally, E. O. Wilson tells us in *Consilience* and the *Future of Life* that we must be both more scientific and more creative in order to preserve our life support systems. These problems can only be addressed by understanding and treating the world as one interconnected coupled human-natural (SES) system.

Systems naturalists suggest a paradigm of a coupled system that promotes practicing economics within the bounds of ecological limits and teaching normative and transdisciplinary education. This education begins with the best knowledge of socio-ecological systems and develops a theory that links science and ethics in a way that is real world, non-ideological, and exclusive of dominion. It counters the premise of both strong

and weak anthropocentric worldviews that see nature primarily in instrumental and economic terms, by grounding economic systems in scientific fact and strong anthropo- and eco-values. Finally, and in answer to the problematic compartmentalization of academic disciplines and approaching, it looks at SES problems from a strong sustainability model. This aspect also builds on naturalists' crucial diffusion of boundaries between theory and practice, natural sciences and the humanities, and university and community with the recognition that ecological and human values can be found in the study of the relationship between nature and humankind.

Collectively, these thinkers can be much more useful to our current environmental challenges than their present treatment in sustainability literature or the categories "nature writing" or "science writing" suggest. In the final chapter of this dissertation, I will discuss in broad terms where we have been and where we are going.

CHAPTER 12: TOWARD A MORE TRANSFORMATIONAL SUSTAINABILITY DISCOURSE

Each chapter of this dissertation has framed a current SES and sustainability challenges such as climate change, biodiversity loss, and rising consumption, as well as having with multiple and cascading socio-ecological effects, then suggested that these problems are integrated with the other SES problems. I also suggested that societies have historically had similar problems, recalling how Jared Diamond (2006) for instance discusses pre-industrial societies as having problems of “soils, water” and “climate change and biodiversity losses” (p. 35). Therefore sustainability discourse can turn to the intellectual history of naturalists for the roots of not only the problem but solutions as well.

Contemporary sustainability discourse often replicates past assumptions about knowledge and value in the three branches, and historical systems naturalists can help overcome aspects of these inherited problems. The problems I covered were in sustainability paradigm, or deep sustainability theory, were:

1. idealistic and non-scientific holistic ideologies, as characterized by Platonic thought; and
2. *dominion* ideologies, as characterized by Linnaeus and hierarchical, and outward appearance instead of ecological role.

In linking sustainability theory to sustainability practice, I highlighted the problems of:

3. *environmental externalities*, as characterized by the settlement of America in agriculture, forestry and fisheries; and
4. efficiency-only measures such as that characterized by Progressive Era conservation.

And in sustainability educational theory or pedagogy I discussed the problems of:

5. *weak sustainability* models, such as the scientific management that led to the Dust Bowl in America; and
6. compartmentalized knowledge, which does not meet the criteria of sustainability's demands for integration.

For illustration, I provided a background chronology of past SES challenges for civilization in Chapters 5-10 as follows:

1.) I first described idealistic and non-scientific holistic ideologies as those presented by the philosopher and first social scientist, Plato. This highly influential philosopher viewed human beings as separate from nature, and the natural world we lived in was as one dimensional like shadows on a cave's wall in comparison to that which arose out of "primitive" and the unscientific thinking of divine order (Mumford, 1961, p. 121). Not only did these philosophical, spiritual, and ethical worldviews set man at odds with nature, but Platonic and idealistic thinking also subjugated the world as one created for men.

2.) Next, the normative Christian ideas, values, and principles during the Enlightenment were tacitly idealistic, Platonic, and orderly (Farber, 2000; Worster, 1994a). In a highly influential example of Platonic idealism and Christian dominion thinking during the Enlightenment, Linnaeus presented a hierarchical structure that linked providence to the exploitation of nature for economic growth. Linnaeus substituted the "Supreme Engineer" for Plato's concept of a "Spirit of Nature," and the "Sublime" (Worster, 1994a, p. 42). This worldview would eventually lead to massive environmental exploitation through colonialism and the industrial revolution (Kingland, 2005, Nash, 1973; Wilson, 1998, Worster, 1985; 1994).

3.) Colonialism in US expansion into previously pristine territories during the rise of industrialism through the nineteenth century is a prime example of

environmental externalities. During European colonization of the Americas, settlers had all but extinguished Native American agricultural methods that restored important nutrients to the soil (e.g., burning and allowing land to lie fallow). Furthermore, while not all pioneers saw the natural world as an enemy, pioneers may have simply been unable to see the forest through the trees (Nash, 1973). Although the first population ecologist Thomas Malthus' warned that exponential growth and expansion would lead to war, famine, and destruction (as it did for most species), colonialism spread the values of industrialism and efficiency around the world. Pioneers devastated integrated forests, prairies, and riverine systems in the US, and homogenized many ecosystems.

4.) With efficiency as a main driver of a civilization that one day dreamed of freeing itself from manual labor, exponential increases in production (and subsequently, consumption) was discovered to be what is now termed the Jevon's paradox. In 1856, William Jevons noted that despite England's stated normative goal of conserving coal for future generations, improving the efficiency of a train's steam engine resulted in exhausting the country's supply over the next 150 years. Why? The more efficient the engines became, the cheaper and more in demand they became. Factories were built that also improved the efficiency of engine production, which in turn, created yet more demand, which in turn created an even bigger market where competition necessitated more efficiency, lower prices, and even greater demand. But being the trains also were the best transporter of coal, this allowed for the building of more machines—often for clothing and textiles, that relied on coal, the building of more tracks, and more over all speed and efficiency (Hallet, 2012; McDonough & Braungart, 2006; Owen, 2012).

5.) Much to the chagrin of John Muir who fought for the preservation of nature for spiritual and aesthetic purposes, Gifford Pinchot embraced such efficiency methods for the US forests. This platform was later applied to fisheries and agriculture. These

practices had devastating impacts on the US economy, culminating in the Great Depression. The “Dust Bowl,” which in many ways contributed to the Great Depression, was a result of legislators and farmers failing to understand the ecology of the Central Plains. They assumed that the agricultural principles of the East and its temperate climates could be applied to the Southwest by the mere addition of water. It was the “progressive farming” following the stock market crash, however, which drove monoculture, machinery-intensive farming practices to increase national production that would irrevocably alter the biotic community of the West (Worster, 1979).

The utilization of mono-agriculture produced an agricultural culture that, in time, wholly lost its resiliency. Nutrients set down over millions of years were quickly depleted by these intensive, widespread farming practices. When prolonged drought occurred vast quantities of dirt were lifted by seasonal winds. The drought and the loss of agricultural lands led to widespread poverty and hunger, as well as mass migrations to places more inhabitable.

6.) After WWII, technologies sped up extraction of natural resources of timber, fuel, water and agriculture in America at an unprecedented rate. By 1947, for example, the chainsaw had been perfected, allowing timber cuts to take place “100-1000 times faster” than before the war (Mosley, 2010, p. 40). Natural resources and ecosystems were increasingly defined as “outputs and products” (Meine, 2004, p. 47). From the beginnings of scientific advancement, “forest industrialization” perpetuated an overwhelming rate of change (Meine, 2004, p. 47). The acceleration of discovery, followed by dependency on ever-rising levels of technology to meet daily needs during the second half of the century, further compartmentalized sciences. At the same time, the seeds of transdisciplinarity, which recognizes the need to center learning on problems of coupled systems, to link theory to practice, and to unite principles from the three

branches in order to solve sustainability sciences most difficult SES problems, were planted.

Analytic Results



Figure H. Analytic Results. The six principles of systems naturalists for sustainability paradigm, practices, pedagogy.

Six of the naturalists' most foundational principles—and principles that address these that explored in this dissertation (Figure H.) come from four naturalists from the American environmental tradition. I have called them *systems naturalists* because of their proto-coupled systems, proto-ecological economics, and proto-transdisciplinary thinking. Throughout this work, I have held that the principles espoused by these naturalists should be leveraged to clarify, enhance, and advance sustainability theory practice and education. I hold that as proto-ecological and systems thinkers, they can

help guide us through the growing complexity and uncertainty in the twenty-first century.

I have examined how Henry David Thoreau (1817-1862) synthesized scientific and philosophical discourse. Thoreau lived during America's rising industrialism in an era that naturalist E. O. Wilson (1998) and environmental historian Laura Walls (1995) refer to as a unique time in history time. This was a time when the three branches—the sciences, social sciences, and humanities—were thought of as an interconnected body of knowledge. As Walls (1995) puts it, Thoreau consolidated two competing narratives during his era, which she calls rational holism and empirical holism. I have posited that he integrated disparate natural and philosophical concepts for sustainability thinking. As one of the few non-Native Americans in his time who admired the lifestyle of the Native Americans, he provided a model for reducing net impact based not on luxury but on needs, and developed a nuanced, contemplative, and ethical relationship between nature and culture.

I have also examined the writing of Aldo Leopold (1887-1948) and his interdependency and normative-thinking ethics that reacted to “progressive” thinking at the turn of the twentieth century. Ben Minteer (2006) and Bryan Norton (2005) have elucidated Leopold's pluralistic and transdisciplinary worldview that presents a more grounded and practical “third way.” Leopold's worldview merges polarized ideological thinking like preservationist vs. conservationist and environmentalist vs. economist in the tradition of *environmental pragmatism*, and through experimentation toward an effective integration of pluralistic values.

Rather than focus on Leopold's practical experience, I delve into Leopold's deep theory in *Sand County Almanac* (1949) to discover how his most developed view results not in compromise, but in leaning more toward staunch restoration and preservation.

Leopold, who witnessed the creation of our national parks and spent a lifetime fighting ideological disputes among disparate interest groups like hunters, planners, forestry and fishery harvesters, and farmers, eloquently clarified ideological conflicts that prevent the fusing of natural and social values. When all is said and done, Leopold favored stewardship over instrumental policies, and he exposed ideological arguments that prevent important environmental practices from being part of everyday society. I ultimately rely on his practical experience, as he spent as much time in the university as in the field, for pathways of integrating epistemology toward a normative sustainability framework based on a long-term relationship between economic science and ecological science.

During the “New Age of Ecology” (Worster, 1994a) as it develops during the post-WWII era in America, Rachel Carson (1907-1964), an ecologist who worked for the US Bureau of Fisheries and Woods Hole, sought intellectually to convey the beauty, dynamism, and fragility of the global biosphere. Like Leopold, Carson (1951), a winner of the National Book Award for her poetic depiction of the interconnectivity of land and sea life, shifted gears later in life. In her final book, *Silent Spring* (1962), Carson brought forward concerns about the unprecedented as well as incalculable costs of agricultural externalities, demonstrating the toxic effects to human beings and nature. She ushered in a new, illuminating, and highly critical perspective on the rapidly increasing global externalities of human activity.

Carson’s realization of human-natural interdependency is one of the reasons that *Silent Spring* became the strikingly instantaneous catalyst of the environmental movement. Her greater body of work presents a new ecological vision for transdisciplinary thought by focusing on interconnectivity of land and sea; pollution on a global level; multi-generational environmental problems and risks; and the connections

among chemical, hydrological, soil, ocean, and atmospheric science. In short, she initiated what Lawrence Buell (2003, p. 31) calls the “toxic discourse” that connected human and natural systems. Carson thus offers an apparatus for an integrated SES-based critique of our relationship with nature.

Like Carson, Edward Osborne Wilson (1927-) provides a contemporary model for transformational and transdisciplinary education, balancing economics with science and ethics. The only living naturalist of the four, Wilson has witnessed the environmental movement of the 1960s and 1970s as well as today’s most modern advances in genetics, evolutionary theory, and what is now often called the *Anthropocene Era*, or “6th extinction period.” As a self-proclaimed naturalist who ubiquitously refers to the first three systems naturalists, Wilson encapsulates a naturalist worldview for today’s SES problems. Like Thoreau in his most mature phase of writing, Wilson steps outside of his home scientific field into philosophy, religion, literature, and the arts to develop a theory of its connections to geology, anthropology, biology, ecology, and genealogy based on the modern evolutionary synthesis (1936-47).

Analysis of Wilson’s work culminates in recent books, especially *Consilience: the Unity of All Knowledge* (1998) and the *Future of Life* (2002). Together, these works provide a contemporary, scientific, and comprehensive view of how natural and social systems function. In particular, his sophisticated development of transdisciplinary fields like *sociobiology*, *biophilia*, *conservation biology*, and the revival of William Whewell’s nineteenth century idea of *consilience* contribute to a human-natural ethic of enlightened self-interest—an evolutionarily based argument for the human affiliation with nature and a worldview driven by planetary survival that can help link SES problem-solving.

While many sustainability scholars interviewed had not explicitly stated previously that education was the problem, when we arrived at this set of questions they seemed excited that we were now reaching the root of the problem. Many respondents thought education had mostly failed at transmitting sustainability principles to date. Education, as Gary Lynne (2014) said, has helped keep things in “business as usual” mode. With regard to the educational theory for sustainability, Kellert (personal communication) stated,

We must emphasize that sustainability is more than just minimizing harm to the natural environment and not standing still. It’s as much about creating a relationship with the natural world. Any species has the right to survive within an ecosystem, consistent with needs and aspirations. It’s not just about the harmful impacts, but understanding context—an elephant changes the savanna; but more than that, it’s also an element and system of which it’s a part.

SES Problems

I have argued that the sustainability paradigm should arise from socio-ecological system (SES) problems, and principles provided by system naturalists—not by economic, instrumental, and efficiency-based solutions that do not match the size and scope of the problems at hand. Several analyses have human beings as already surpassing Earth’s carrying capacity, to equivalent to 1.2 to 1.5 of our Earths (Meadows, Randers & Meadows, 2004; Pijawka, 2015; Rees & Wackernagel, 2012). If we take these estimates of our ecological footprint as the truth—or even close to it—system naturalists would probably say we need to intensify our efforts to preserve (and restore when possible) the natural diversity of global ecosystems. Diluting sustainability thinking with more efficient extraction methods may meet the theoretical demands of equity, economy, and

environments, but this diluted, non-environmentally-focused approach still exhausts the planet beyond repair.

Efficiency methods have historically failed to protect ecosystems, but they have increased production and consumption. In the end, they may only succeed in facilitating the efficient destruction of the ecosphere. Similar to Rees and Moore (2013), who have estimated overshoot of carrying capacity at “1.5 planets” (p. 44), the World Wildlife Federation estimates the EF in terms of time. “It would take 1.5 years to produce the amount consumed in one year” (WWF, 2014), suggesting that every year we eat more substitute more “corn seed” for economic capital, as if the substitution in value is equivocal. Wilson write of our “Anthropocene Era,” implying another race looking back on our extinct culture, “like the conquistadors who melted the Incas gold, they recognize the great treasure must come to an end—and soon” (p. 123).

Many of system naturalist suggestions as you will see depart from incremental and efficiency based solutions but at their core are more transformational. Transformation has been argued to be “necessary to avoid mounting crisis and even possible future collapse” (Hopwood, et al., 2005, p. 41). Since, we are at or have surpassed carrying capacity, and populations are still growing quickly, sustainability demands the use of fewer environmental resources in total, which will come about only as the result of big and transformational measures; however, transformations are not easy, and imply an end to many entrenched ideological stances that protect business-as-usual scenarios.

An Ecosphere of One Coupled System

The ecological footprint (EF) concept has been criticized by the United Nations’ “Post-2015 Consensus Review” author Bjorn Lomborg (2001) for presenting doomsday

scenarios. This is despite Lomborg (2001) calling UN goals of ending malnutrition and providing jobs for everyone as “both unrealistic and uneconomical” (p. 2) and calling for the widespread prophylactics and increased development spending over medicine and education. Both Jorgenson, et al. (2002) and Nordhaus and Shellenberger (2013) have criticized the ecological footprint for being based primarily based on carbon footprint (which Rees and other fully admit) and not allowing for a sudden shift toward renewables that will be returned back to us within carrying capacity. But, the sudden shift to the large-scale use of renewables is not here, and may never come without some drastic changes to the way we see, treat, and think about culture, economics, and ecology.

I have suggested that we frame sustainability around the issues of socio-ecological system (SES) problems that most threaten a global carrying capacity that we have now reached or surpassed. In doing so, I have highlighted three of our most critical SES problems: human-induced climate change, biodiversity loss and extinction rates, and rising consumption patterns in both developed and developing countries. Increase in atmospheric carbon dioxide (CO₂) levels are unprecedented over the past 800,000 years; and if the rising rate of greenhouse gases (GHG) is not curbed, the Earth’s average surface temperature could increase from 4.3 to 11.5 °F (2.4 to 6.4 °C) by 2100 (IPCC, 2014). Ecologists estimate extinction levels at 100-10,000 times the background rate of historical species loss, and the increasing specialization of human-welfare outputs has resulted in the homogenization of forestry, agricultural products, and other human subsistence outputs now essential to our lives. Finally, rising consumption patterns centered on an ever-growing middle-class, has created an incessant demand that forces energy, agricultural, meat, fish, lumber, pulp, and paper multinationals to use increasing

dangerous and invasive methods that convert natural capital to match rising levels of demand in the developed and developing worlds.

The problem, as Leonard (2009) puts it, is simply that throughout recent history there has been “more absolute growth overall: or people extracting, using, and disposing of more and more *stuff*” (p. xix). Because of the way systems work, we can create better social and natural systems, but fail in global sustainability because “the subsystems needs to fit inside the constraints of the parent system” (Leonard, 2010, p. xviii). Sustainability scholars interviewed were acutely aware of the magnitude and nature of the sustainability issues as defined in the first chapter of this dissertation, and were well versed on the breadth of contemporary sustainability theory.

Much of today’s sustainability practices are not grounded in the realities of SES challenges and the parent system circumscribed by the term global carrying capacity, presenting a serious obstacle for sustainability practices. In particular, industry and finance leaders have framed the wilderness and its diversity as an obstacle to, rather than a source of, societal happiness. Examples of this are many, such as offshore mining for fossil fuels, the Keystone pipeline [C5], fracking for natural gas, and other environmentally threatening and at times dangerous methods in the US designed for a more sustainable, or secure, nation at the expense of a sustainable future.

In her final book, *Dark Age Ahead* (2005), the urban activist Jane Jacobs foresaw a coming dark age because of crumbling family life and community welfare due to wicked social problems: because of a consumerist and individualistic culture; because economics is the main science of consideration for most governments; and because universities seem more interested in growing through publishing than providing high

quality education. Of our social duty—not only to nature, but also to ourselves—Jacobs (2006) wrote:

Any institution, including a government agency, that is bent upon ecological destruction, or an outrage on the built environment argues its case or bullies its opponents by righteously citing the jobs that supposedly will materialize, or even more effectively, the jobs that may be forfeited or jeopardized if the ugly deed is not done. To this day, no alternative disaster, including possible global warming, is deemed as a dire threat to job loss. (p. 59)

While Jacobs does not address ecological collapse in *Dark Age Ahead* (2005), in her penultimate book, the *Nature of Economies* (2001), she describes this cultural malaise in terms of collapse, driven by a lack of evolutionary, or dynamic abilities to change. Nature itself, she (2006) argues, provides an elastic and pulsating model for future economies, which unlike current systems, provide the ability to address destructive feedback loops and replace them with beneficial ones.

Sustainability in a Word

Countless environmental-oriented professionals and academics have warned us of the theoretical challenges of the six-syllable word sustainability, (as demonstrated in the Chapter 1 and 3), interpreting it somewhat as linguists (and the handicapped) have interpreted terms like “handi-capable.” In a recent guide to writing history and nonfiction, environmental historian Stephen Pyne (2009) ranks two of his five most exemplary jargon and clichés in writing are “sustainability” and “interdisciplinary” (p. 139). The first he calls “fatigued into meaninglessness;” the second, he calls “beaten into a witless pulp” (p. 139). “Sustainability,” writes environmentalist Bill McKibben in a 1996 *New York Times* column “is a buzzword without the buzz. Though the word has variously

been championed as a challenge to or an obfuscation of the word growth, “‘Sustainability’ is doomed because it does not refer to anything familiar. We understand ‘growth,’ because everything that lives grows.”

Many environmental theorists have characterized the three-pillar construction as formulated by *The Brundtland Report* (1987) and expressed in UN literature—as so ambiguous as to be meaningless (McKibben, 2009; Newton & Freyfogle, 2005; Vucetich & Nelson, 2010). The sustainability framework that dominates contemporary discourse—stresses balanced relationships among the “three pillars” or “three E’s”: economics, environment, and social equity. While in theory the mainstream sustainable development model attempts to achieve a compromise between economic development and environmental conservation, in practice its tenets are often so vaguely defined that stakeholders from industry, government, and business interpret to suit their own private economic interests (Kates, Parris & Leiserowitz, 2005).

After more than a quarter of a century since the *Brundtland Report*, practitioners have generally interpreted sustainability according to economic, rather than ecological or ethical interests (Adams, 2006; Constanza, 1993; DuPisani, 2006; Jamieson, 1993; Kates, Parris & Leiserowitz, 2005; Solow, 1993; Svara, 2010). This has been attributed to a lack of agreed-upon indicators (Kates, Parris & Leiserowitz, 2005); the difficulty of discussing normative values as metrics (Pijawka, 2015); and where locally based indicators exist, they “need not be linked to ecological science at all” (Newton & Freyfogle, 2005, p. 28). Furthermore, an economic, technocratic, and anthropocentric environmental theory, such as that proposed by Shellenberger and Nordhaus in their “Death of Environmentalism” manifesto and their follow-up book, *Break Through* (2004; 2007), has been increasingly ascendant in sustainability theory in recent years.

Once the *Brundtland Report* (1987) captured the attention of development and planning theorists and practitioners, “trading-off” among the three pillars became a standard part of all sustainability planning. Yet the compromise between environment and economy, and the trading-off between ecological and economic values are fundamentally incompatible with the preservationist and restorationist principles of naturalists (Redman, personal communication, 2014). The spatial and temporal scales with which sustainability is concerned are *not* addressed by the *Brundtland Report*. The UN-based literature, like Brundtland, has done little to protect land health worldwide and preserve carrying capacity as its stated goal in the report (Shiva, 2000; IUCN 2004). The environmental footprints of most developed countries extend far beyond their borders. And as developing countries’ populations continue to grow exponentially, and as they become more unstable and are unable to satisfy their own needs, population growth and consumption among the global middle class is likely to decimate the ecologies of many biodiversity hotspots, and increase the rate of historical over-consumption patterns, if not contained (Brown, 2011; Wilson 2002).

There was almost majority consensus among sustainability scholars interviewed that the concept *sustainability* needed to be “re-conceptualized” (Meine, personal communication, 2014), if not “replaced” with other terms (Bill, Herzog, p.c., 2014). In fact, many suggested it “must” be or “inevitably will be” replaced although the name itself was not important (Herzog, , personal communication, 2014). Sustainability scholars also agreed that the *concept* of sustainability needed to be “enhanced” or “re-thought” (Redman, , personal communication, 2014). Redman (2014) had no problem seeing the term fade out of practice, as the “name [sustainability] is problematic” because it has “no grounding.”

Curt Meine (personal communication, 2014) argued that sustainability was a transient word. He suggested the simplicity of Leopold's "land ethic" a short, non-partisan expression of natural-human systems that could appeal to anybody. Bryan Norton (personal communication, 2014) now calls it the planet ethic. Many names offered as preferable alternatives to the name sustainability, such as "restoration ecology," "conservation biology," "resilience" (especially by international members like Bill and Herzog), and "land ethic" by Curt Meine. He further suggested that Leopold understood it correctly many years ago: use simple terms that everyone can support and that mostly avoid environmental partisanship. "Earth-ethic" (Norton, personal communication, 2014), and "human and ecological wellbeing" (Santone, personal communication, 2014) were used as new and more useful terms to describe the goals of sustainability. "Agricultural sciences," "experimental sciences," and "urban planning" were used to describe the most important means by which we obtain sustainability.

Ecological Sustainability

In order to base sustainability on social and ecological health and wellbeing that is based on the long-view of SES which sustainability is concerned, this dissertation focused on answering how the principles of the foundational naturalists and holistic thinkers could help clarify, enhance, and advance sustainability discourse. I examined the current sustainability paradigm, its common practices, and university pedagogy. I asked, how could they capture a fuller range of human and natural values, present an integrated ecological and economic worldview inform their work? I asked why was this perspective critical to programmatically operationalize naturalist thinking in sustainability discourse and education?

Sustainability scholar David Owen remarks in *The Conundrum: How scientific Innovation, Increased Efficiency, and Good Intentions Can Make Our Energy and Climate Problems Worse* (2011), “One of our favorite green tricks is reframing luxury consumption preferences as gifts to humanity” (p. 3). Examples include “Naturalists have a lot to contribute to policy and practice” (Kellert, p.c., 2014). Nevertheless, sustainability scholars often disagreed on what this would entail. For instance, many were adamant that ecology must guide practices. The decoupling and “disconnect of ecology and economics” that began with the Industrial Revolution and transformed the world economy, also changed the worldview to one of natural resources with the sole functions as fuel for the economy only. While Norton (2014), who remarked that our country had relied on natural resources for national security since at least World War I, others said it began with the Agricultural Revolution.

While Owen goes on to say we still do not know how to make the world more equitable, we do know how to prevent people, and nations, from exploiting natural resources: charge more money. Owen (2012) and others (Picketty, 2014) have pointed to a global tax aimed at multinationals and the highest earning individuals. “Any truly effective strategy will soak the rich” (Owen, 2012, p. 248). But neither the top-tier of the Global North, nor the average, disenfranchised citizen of the Global South—with sometimes fractions of a percent in ecological footprint of the average Global North citizen—have not yet been willing to pay for the attendant costs associated with global climate change, biodiversity loss, and rising consumption levels that result in the drastic reduction in the availability of food, water, energy, forest, and ocean products.

The contemporary sustainability paradigm is still rooted in historical dichotomies of anthropocentric and non-anthropocentric worldviews, economic and environmental

practices, and traditional multi-disciplinary university frameworks where the integration of scientific and normative values are often fail to happen on more than a superficial level. The reason sustainability thinking has not made the world more sustainable is because our thinking has in many ways replicated assumptions about knowledge and value in both the sciences and the humanities. In response, each chapter of this dissertation presented current sustainability challenges and SES problems, then turned to an intellectual history for both the roots of the problem, and the roots of the solution. I have proposed the knowledge contained in the tradition of naturalists—as not only proto-ecological thinkers, but also holistic thinkers who understood cultural barriers to sustainability—can overcome significant aspects of this inheritance, and found sustainability discourse in an American environmental tradition that linked important principles from science and ethics.

Sustainability, like the environmental movement of the 1960s and 1970s, most often arose not from theories and frameworks but serious problems, which inspired activists such as Lois Gibbs of the Love Canal, and Bill McKibben of 350.org, who have responded singularly to dauntingly real and profoundly problematical environmental issues (Norton, p.c., 2014). McKibben (p.c., 2014), an environmental writer and climate-change activist who founded what the *New York Times* calls the largest activist organization ever, emailed me his interview. He wrote, echoing Leopold:

[E]cology—the idea that everything is connected—was the most fundamentally important discovery of the twentieth century, far more useful in the long run than atomic power. And of course it was really only a discovery in the West; it was taken for granted in older and deeper cultures.

When asked which of the four system naturalists were most important to sustainability discussions, McKibben (personal communication, 2014) framed them all as ecologists and activists:

[T]hey're all very important to any discussion of a workable world. Thoreau was a consummate naturalist and a natural activist; Leopold understood far better than Thoreau the importance of community (natural but especially human); Carson was the first person to really take the shine off modernity; and 'Ed' is not only the greatest scientist of the bunch (though Leopold gives him a run for his money) but also a powerful conservationist.

System naturalists have described the root of the problem in placing the health and wellbeing of humankind in opposition to that of nature and ecosystems. To develop sustainability systems that subvert old ideas about the relationship between nature and culture on a global level is an enormous undertaking. But, it is one Wilson and most ecologists feel we will become more and more aware of as arable land, productive fisheries, coral reefs, first-growth forests, species diversity, sustainable rural communities, potable water, and glaciers become more scarce, more expensive, and in many cases, extinguished from our natural world.

The enormousness of the challenges our global community faces in the twenty-first century, is an enormous undertaking. Yet, many scientists who study carrying capacity have suggested radical changes. To cite one of the now clichéd metaphors regarding the shift in living comparable to the mobilization of the entire nation as in fighting the Axis powers during World War II. Yet, this metaphor and concept are fitting for the socio-ecological system (SES) problems that threaten global carrying capacity. Whether you call it conservation, sustainability, conservation biology, or resilience, or adaptive capacity, the problem of *not* "eating your corn seed" suggests fully dealing with

SES problems requires an integrated framework of the normative sustainability paradigm, linking ecological and economic theory and practice, and merging principles from the three branches.

Last Words

The view of Earth from space reveals not that the Earth is metaphorically like a “space-ship”—a technological achievement—but rather that all life in the solar system lives in a closed-system. Except for sunlight, no resources go in or out. Whether framed environmentally as ecosystem resources, or economically in hard numbers, this means that the unsustainable use of resources beyond natural recharge rates, and in ways that pollute the atmosphere, and diminishes biodiversity, is decreasing the actual and tangible health and wealth of the planet. Human health, wealth, and wellbeing—important though they are—will be less important in the ecological long-run and to our grandchildren—than the fruits of preserving and restoring natural capital.

System naturalists call for a much more transformational sustainability based on SES problems. In a world where both society and nature have been culturally constructed as in Platonic idealism (and often in denial of real environmental problems), each of the four system naturalists of this study help ground us in real-world and imperiled cultural and natural systems. This sets an example of creativity, non-conformity, and it is Thoreau’s particularly agile ability (like Aristotle and Buffon) to make inferences about society from his findings in the natural world that has inspired so many naturalists, ecologists, and environmentalists.

These four naturalists from the American environmental tradition suggest a more transformative and ecologically based sustainability discourse. Today, Thoreau is often accredited for spawning our first “land ethic” as well as “environmentalism” itself

(Wilson, 2002, p. 144; Worster, 1994a). Leopold became a forerunner of a one-coupled-system worldview and introduced a new paradigm of SES problem-solving for sustainability discourse. By exposing our dependency on ecosystems as a whole, as well as the inherent instrumental value of appreciating what we cannot yet fully understand, Carson and Wilson began with a deep understanding of human-natural interdependency and the fragility of natural systems, before identifying civilization as the key to ecosystem sustainability.

In final, to answer to the question “What is sustainability?” I submit that the system naturalists might define it not as a new science; or a new field; or a new framework; or matrix of sustainability indicators. Rather, they would define sustainability as a set of problems that threaten cultural and natural health and integrity. System naturalists seem to have interpreted sustainability as it not in terms of outcomes or solutions, but as core, systemic problems and challenges.

The historian, novelist and environmentalist Wallace Stegner (1909-93) said, “conservation is a task.” Conservation biologist, Curt Meine (2004), the leading national Aldo Leopold scholar in his most recent book, has called conservation “the oldest task in human history,” relating it to the Native Americans and the Ghost Dancers who upon the Great Plains a hundred years ago “tried to dance [the world] back into existence” (p. 15).

System naturalists have generally interpreted anthropocentric worldviews, economic-based conservation policies and projects that interpret sustainability as in beneficial terms of output, and the lack of education about ecology as problematic to plant, animal, and human health and wellbeing as serious challenges. These challenges demand a change in the worldview of our relationship with nature, the management of our economic system, and the revitalization of a relationship between governments,

businesses, communities and educational systems that has so far failed to make the world any more sustainable, and has not learned from the lessons of the past.

The origins of SES challenges appear throughout prehistory to today. Since the beginning of the agricultural revolution shifting climates, over-farming and hunting which lowered soil carrying capacity and extirpated prey, and rising consumption that was dependent on the continued expansion and conquest, has turned ancient civilizations into crumbling empires. The first policies during the Enlightenment, as forests were being depleted for shipbuilding, conquest, and the fueling of first seeds of industrialism, sent us to the far corners of the globe in search of more and more raw materials. During the Progressive Era (1890-1920), the creation of the first national parks, and the end of the American West, we sought to make the land we had ever more productive, in an increasingly more crowded United States.

The environmental movement the 1960s and 1970s, not at all the first plea to restore and protect ecosystems, was not an efficiency movement, but a protest of the continued ignorance of the growing toxicity of air, land, ocean, and riverine systems during the acceleration of production and consumption following World War II. The general awareness and discussion of carrying capacity, which has its origins in Malthus, begin with the findings by international and interdisciplinary groups such as the authors of *Limits to Growth* (Meadows, et al., 2004). *The Limits to Growth* (1972) sought to elucidate five socio-ecological system problems in need of alteration to prevent complete and catastrophic social, economic, and ecological collapse. The authors stated that global transformations were needed in five categories: *population, industrialization, pollution, food production, and resource depletion*. I assert the environmental movement of the 1960s and 1970s—directly inspired by writers like Thoreau, Leopold, and Carson, and

taken extremely seriously by then young scientists like Wilson—saw the world in crisis, and largely had the problem of sustainability framed correctly over fifty years ago. The discussion about sustainability arises, as has environmental movements, from real-life socio-ecological system problems.

Wilson (1992), who has mixed feelings on the long-term outcomes of the environmental movement, writes in the afterward to *Silent Spring* that “the Carson ethic spread to other countries” and “accelerated the resistance to chemical pollution that is all but universal today—in word if not always in deed” (p. 361). In the thirtieth anniversary publication of *Silent Spring*, Wilson (1992) wrote:

Rachel Carson, who was a quick learner, would be ahead of us still in understanding the devastating effects everywhere of still-rocketing population growth combined with consumption of natural resources, the thinning of the ozone layer, global warming, the collapse of marine fisheries, and, less directly through foreign trade, the decimation of tropical forests and mass extinction of the species. She would regret, I am sure, the sorry example the United States sets with its enormous per capita appropriation of productive land around the world for its consumption -- ten times that of developing countries. (p. 363)

Legislators and leaders from around the world struggle now to give treaties and conferences some teeth to overcome these impediments. However, developing an effective international agreement is proving difficult. This was evident in the Copenhagen and 2014 Warsaw conferences that witnessed ever-growing frustrations, especially by representatives from developing countries who often walked out of the proceedings in protest or to form their own sub-groups and decision-making bodies.

Tradeoffs between sustainability domains “indicate the continued conceptual divide between the environment and humanity,” argues Hopwood et al. (2005) Since The *Brundtland Report* in 1987, we have continued to develop and expand indicators based largely on trading off between 3 or 4 or 5 pillars, but the now hundreds of pages of types of indicator sets, and often hundreds of indicators per set, seem only to add to the complexity. What is new about our problems is that our big sustainability problems (especially climate change, land health diminution, and population growth and consumption) is that our systems are more tightly interconnected than ever before, and that these problems have no testing ground, and we only have once to get it right (Rittel & Webber, 1973); otherwise the problem of how to sustain a growing civilization is not new.

As system naturalists since Thoreau have told us, we cannot continue in many of daily activities without alienating human beings from nature and other human beings alike. Insofar as UN interpretations of sustainability are founded on working within the same systems that caused our largest SES- problems in the first place, we are not addressing the problem of sustainability. Beginning with Aristotle and throughout history, philosophers have known that neither language, nor the language of money, can represent nature (Foucault, 1973, p. 61). Economics for Aristotle did *not* espouse accumulating wealth, but “altogether parts with modern economics to become a treatise on the ethics of family life” (Barker, 2013). Instead, he insisted that we look at the “function of man” toward the community, which is always larger than any one individual’s—or group’s—satisfaction.

Yet, despite all the difficulties of bringing together diverse ideas, institutions and knowledge systems, people who would have never before sat down together have reached

agreement within the framework of *sustainability* and *sustainable development*. In this sense, sustainability's ambiguity can be considered as an asset. Keeping all these problems in mind, we must reinvent programs and policies based on efficiency only to those that preserve natural resources, biodiversity, and our life-support systems for many generations to come. The future success of the sustainability paradigm, or its failure as a constructive discourse, depends on its dedication to overcoming SES-challenges that respond to the global socio-ecological system crises that face us today.

Naturalists, scientists, and ecologists are well versed in how human society and development have shaped the environment and who are most apt to provide the foundations for sustainability. The system naturalists have never believed that sustainability can be based solely on trade-offs between economic and ecological values. With much of the emphasis on local planning, inter-disciplinary fields like *urban planning*, *conservation biology*, *ecological economics*, and *human ecology* have become the main forum for a sustainability discourse; and, this can be especially seen since the introduction of new terms like *ecological footprint*, *ecological thresholds*, and *adaptive capacity* that cross disciplinary borders. Sustainability education and curriculum can consolidate the three branches with these comprehensive concepts and values in a simple way but without marginalizing important principles. The theoretical, practical, and educational principles of system naturalists and environmentalists provide pathways into a transformational paradigm of sustainability that can observe and respect ecological limits needed to ensure the health, well-being, and survival of all living things.

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APPENDIX A
METHODS AND RESULTS OF INTERVIEWS

Methods

The data analysis included the four criteria used for validity and reliability—*construct validity*, *external validity*, *internal validity*, and *reliability* (Yin, 2009, pp. 45, 100-101). When conducting qualitative text analyses, a researcher must often make an “educated guess” about the meaning of a specific text. They consider both the author’s intentions and the most likely interpretations (Bainbridge, 2014). For this dissertation, working with the primary texts of the four naturalists and secondary texts by other authors that highlighted the naturalists’ political, economic, and scientific perspectives, I sought parallels in principles as applied to sustainability thinking and SES problem solving. I applied my findings to design interview questions, which, in turn, reinforced findings in the literature review.

While the analysis and interpretation of the four naturalists’ literature and authorities on their writing is the primary source of inquiry, I also thought it would be valuable to explore each of the four system naturalists from diverse disciplinary perspectives, and various lenses provided by the interviewees. This ensured external validity, achieved through the triangulation of ideas received through primary and secondary sources, and the continual process of taking interviewing sustainability scholars and reading literature on sustainability and the naturalists (See Chapter 1).

As interviews and analysis of ongoing sustainability issues supported the literature review, the methodology was modeled on case study methodology³⁸ to identify concepts, values, and principles of naturalists I may not have understood in reading the primary and secondary literature. Evaluate how each contributed to the eras in which they lived, the various SES problems of those eras, and the solutions drawn from their different levels of ecological understanding.

Literature Review

Primary data collection began with a thorough literature review. The primary *units of analysis* were the authors’ overall meta-narrative found among their writings, and especially in their later and key “manifesto” books (e.g., *Walden: or Life in the Woods* (1854), *A Sand County Almanac* (1949), *Silent Spring* (1962), *Consilience* (1998), and *The Future of Life* (2002), which respectively represent the culmination of each author’s work. For this work, “embedded units of analysis” (Yin, 2013, p. 132) are deep sustainability theory, the theory of sustainability practices, and sustainability educational theory—areas that had enough flexibility to apply to traditional naturalists and sustainability scholars alike.

The construct validity test ensures the evidence collected occurs in a logical and realistic collection process that maintains consistency from the beginning to the end of the research process (Yin, 2009). My committee dissertation committee chair, Dr. Ben

³⁸ I modeled the design of the interviews on the Yin case study (2009) method of “empirical” inquiry, which can be used for this type of research due to its flexibility (p. 39). It typically asks very broad *how* or *why* questions to inform the study of “contemporary phenomenon in a real-life context; when the boundaries between phenomenon and its context are not clearly evident” (Yin, 2009, p. 24). Case studies rely on a rich set of qualitative and quantitative evidence from up to six sources of evidence, “1) documents, 2) archival records, 3) interviews, 4) direct observations, 5) participant observation, and 6) artifacts” (Yin, 2009, p. 37). I used all of these sources in one way or another with a focus on documents, direct observations in the classroom, and interviews. While this is not a formal case study, case studies can be applied to textual analysis as they contain “many variables of interest; multiple sources of evidence; theoretical propositions to guide the collection and analysis of data” (Yin, 2009, p. 17). The purpose of case study research is to generalize theoretical propositions, not to provide statistical research, and can be based on real-life phenomena in historical context (Yin, 2009). Another merit of this method is its revisionist nature.

Minteer, and I carefully considered the selection of each author and the design of the study only after a thorough review of historical naturalists and nature writers, as well as a full review of current sustainability writers. All told, five distinct bodies of literature were used to provide a literature review of naturalist and sustainability theory throughout the dissertation. These include:

- Primary and secondary literature relevant to the four system naturalists
- Sustainability historiography
- Environmental and sustainability ethics
- Traditional and current environmental and sustainability theory

As noted earlier many different disciplines and fields represented by this transdisciplinary set of literatures (i.e., environmental history, history of science, sustainability science, biography, etc.) were evaluated in order to describe the relevance of a principle to sustainability thinking. Reading the core works and criticism of naturalists in general led me to a preliminary theory that naturalists were sustainability and systems thinkers prior to the articulation and formalization of sustainable development and sustainability, which ideas and terminology that appeared late in the post-World War II era.

Internal validity in this dissertation was confirmed with theory-related analytic generalizations and pattern matching, not statistical generalizations. Finally, analytic strategies included following the case-study design and explanation of the general characteristics, relationships, and patterns of the theoretical propositions. I examined expected outcomes and rival explanations by looking for the following:

- consistency of the systems naturalists' writings;
- examples of their systems naturalists' principles;
- illustrations of specific systems naturalist principles;
- agreement among the four systems naturalists;
- opinions of contemporary and competing naturalist views;
- agreement between systems naturalists and contemporary sustainability scholars;
- agreement between systems naturalists and my own thinking; and
- agreement between contemporary sustainability scholars and my own thinking.

Reliability ensures that other researchers can replicate findings. Administering the same set of questions regarding sustainability discourse to each interviewee ensured this.

Interviews

The sustainability scholars interviewed were identified in part because their work reflected an understanding of both sustainability and most of the four system naturalists. All interviewees were familiar with at least three of the naturalists, their writings, perspectives, and values. Analysis of the primary documents together with the interviews with these sustainability "thought leaders" helped reveal shortcomings in current sustainability thinking. Interviewees included:

- Timothy Beatley, Professor of Sustainable Communities, University of Virginia
- Amber Bill, Manager Community Engagement & Reserves, Parks and Gardens Wellington, New Zealand
- Peter Brastow, Senior Biodiversity Coordinator, City of San Francisco
- Edward Cook, Associate Professor, the Design School, Arizona State University
- Cecelia Herzog, President of Green Infrastructure and Urban Ecology Institute, São Paulo, Brazil

- Stephen Kellert, Tweedy Ordway Scholar, Yale University
- Julie Klein, Professor of Humanities, English, Interdisciplinary Studies and Faculty Fellow, Office for Teaching and Learning, Wayne State University
- Dr. Gary D. Lynne, Professor of Ecological Economics, University of Nebraska,
- William “Bill” McKibben, Environmentalist, Author, and Journalist
- Curt Meine, Senior Fellow, The Aldo Leopold Foundation
- Bryan Norton, Environmental Philosopher, Georgia Tech University
- Michael Popejoy, Fellow in the Department of Philosophy, Harvard University
- Dr. Charles Redman, Founding Director, School of Sustainability, Arizona State University
- William Rudy, Director of Campus Sustainability, Brigham Young University
- Susan Santone, Executive Director, Creative Change Educational Solutions
- Timothy C. Weiskel, Research Director, Cambridge Climate Research Associates, Harvard University Extension School

Due to proximity, most sustainability scholars were American Academics, but they also included several practitioners (e.g., four working ecologists) and several international academics and practitioners (e.g., Brazil, England, and New Zealand) in order to achieve a balanced critique. No inducement was offered to the participants other than the perceived value of participating in a sustainability study. Interviews (Fall, 2013 – Fall, 2014) took place primarily over the phone and in person, with a few interviewed by email. All interviews were completed by October 1, 2014. The results of the interviews continually informed the formation of the dissertation questions and thesis.

Those interviewed possess an affinity for naturalism or ecology, with many coming from a related specialty field such as *urban ecology* or *ecological economics*. Many work at the intersection of two or more fields (e.g., ecology and urban dynamics, environmental management and economics, sustainability, etc.) as well as at the interface of the humanities, social sciences, and physical sciences. Many of them also investigate human-natural systems much like the system naturalists. Most could be considered sustainability theorists as well as long-time practitioners of sustainability.

Through the course of interviews with this distinguished group of scholars and thought leaders, it became clear that there was significant support for applying American naturalists’ values to current and future sustainability thought, practice, and education. Discussions included where interviewees saw the naturalists’ values coincide or differ from current sustainability thinking, what influence they may have on sustainability practice, and how they can inform the development of a system naturalist curriculum for sustainability education. These in-depth interviews (conducted during 2013-14) proved essential to understanding the full story of sustainability as well as identifying which naturalist principles might make important contributions.

I constructed a set of questions to test this premise through semi-structured interviews. Interviewees (respondents) were given questions and consent forms prior to the interview. Interviews lasted between 20-80 minutes. Interview discussions were usually open-ended in nature and responses often went beyond the realm of the question posed. For example, while interviewing sustainability scholar and ecological economist Dr. Gary Lynne, much of the discussion centered on ecological economics and the intensive graduate-level course he taught during his time at Arizona State University last spring.

At the end of the interview process, the questions and results were organized according to three broad and overlapping embedded units of analysis: (a) deep sustainability theory, (b) the theory of sustainability practices, and (c) sustainability educational theory. Answers provided qualitative data only, which was used to informally “test” the hypothesis that the principles of traditional American naturalists can enhance the current sustainability framework as applied in a university education setting by returning it to long-tested values of coupled socio-ecological systems (SES) and a more transdisciplinary approach common to naturalists.

I used interviews to (1) continually guide and test an evolving set of principles derived from naturalists; (2) guide my thinking about system naturalists’ proto-sustainability thought in the areas of sustainability theory, practice, and education; and (3) to draw cross-case conclusions (and determine external validity). “Figure I. Illustration of dissertation phases” shows the processes of the design, analysis, and concluding during the research.

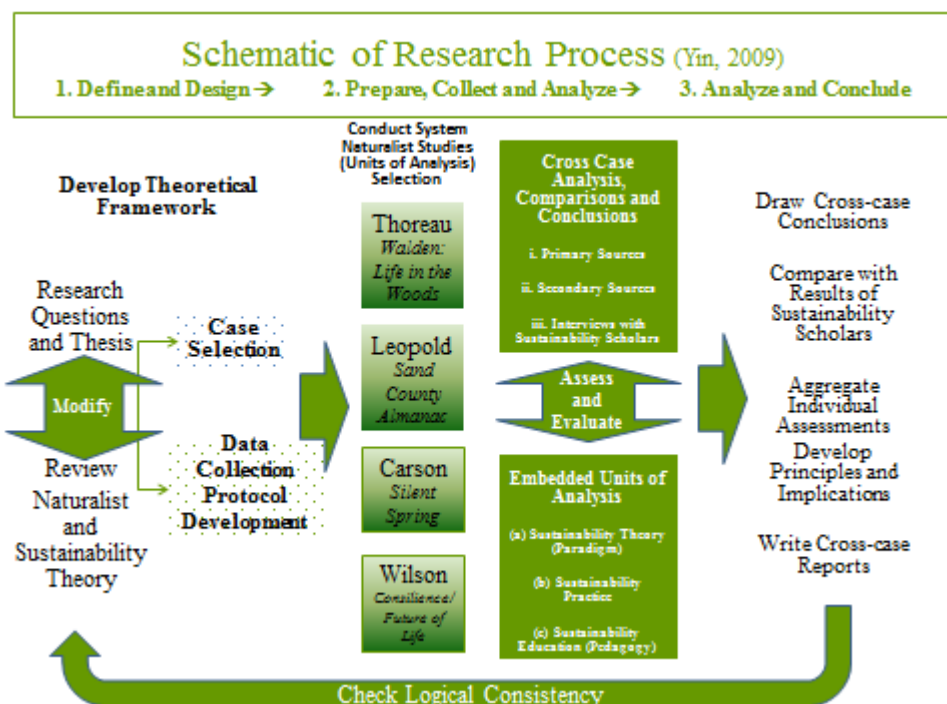


Figure I. Illustration of Dissertation Stages. Design was modeled on the Yin (2009) case study method.

Finally, I conducted interviews with contemporary sustainability scholars to test my ideas and interpretations of the importance of naturalists’ and ecologists’ principles within this context. Discourse analysis supports the researcher’s textual analysis and interpretation of an authors’ work. As this research sought to explain the contrasts between UN literature and the system naturalists writing, the interview questions were specifically designed to answer the question: *How can the principles of the foundational naturalists help clarify, enhance, and advance sustainability discourse?*

The supplementary questions (from Chapter 1): How can a re-examination of traditional naturalists’ thinking expand and improve sustainability’s theoretical framework to make it better capture a fuller range of human and natural values; 2) How

does the holism of system naturalists, particularly regarding the need to respect ecological limits within an integrated ecological and economic worldview inform their work, and why is this perspective critical today to rethinking the contribution of American naturalists to sustainability practice; and 3) How can we programmatically operationalize naturalist thinking in sustainability discourse and education?—also guided my thinking for the interviews.

Limitations of the Interviews

Although the questions were intended to be specific in nature, many of the subjects could not provide a definitive answer. Rather, they often expounded on a singular aspect of sustainability or the naturalists they wished to discuss. I did not attempt to curb the interviewees' propensity to talk about their experiences, their writings, and unique perspectives. Some respondents (e.g., Bill McKibben and Stephen Kellert) were only available to answer a few of the questions, making it difficult for me to draw clear statistical references, such as “twelve of sixteen” or “75 percent of sustainability scholars agreed with ‘concept X.’” In addition, as I sought out persons with backgrounds in ecology and a firm grasp of the naturalists and their works, I continually learned from these interviews, comparing them with the most salient naturalist principles, adjusting them as per the Yin (2009) method, and revising my thesis and supporting arguments throughout the research.

Summary of Methods

This dissertation used a multi-pronged approach consisting of literature review, conference preparation, classroom experience, and interviews with sixteen sustainability scholars. It took place during two phases over the Fall 2013 and Spring 2014 semesters. By triangulating the textual interpretation of the naturalists and the discursive analysis of the interviews, class experiences, etc., I was able to insure *external validity*—that the research findings are applicable outside the confines of the naturalist authors' eras—and *reliability* verifying that other researchers can replicate findings (Yin, 2009). Comparisons of the outcomes of the case study, the class, and the interviews are also defined by their relevance to the larger discourse of sustainability, SES, and transdisciplinary theory. Next, I examine the results of interviews with sustainability scholars.

Sustainability Paradigm Question 1

Where do our cultural and historical histories come into play in sustainability thinking? All respondents said that history was crucial to sustainability. Many respondents referred to “context” and “local solutions” as the main reasons that history is important (e.g., Santone, Meine, Rudy, Norton, personal communication, 2014). Several respondents remarked that while history is often not remembered, it is the most important element in regards to this contextuality. Most respondents basically imparted that sustainability—under any name—must be “adaptive” or a “process” that naturally involves a close examination of local-to-global historical processes.

Sustainability is about “understanding long-term processes” that transcend generational thinking and should be examined through a historical lens and not just statistical forecasting (Redman, p.c., 2014). San Francisco Biodiversity Director Peter Brastow, repeated the sentiment that most do not consider the long-term history of an area. But, such an approach is problematical as historical environmental processes are often not well documented.

As leading conservation scholar and senior fellow of the Aldo Leopold Foundation, Curt Meine (2014) pointed out, “no one has written the history of conservation.” Meine meant the full, integrated history of conservation that would link the earlier resource management tradition with ecology, conservation biology, etc.,

across environmental media (e.g., land, wildlife, water, air, etc.). This lack of data leaves many unanswered questions for an array of contexts.

A number of respondents also reinforced the link between ecology and ethics, seeing ethical commitments as the foundation of sustainability and the special forte of these four chosen naturalists and ecologists. As Byck (2014) said, “Sustainability is ecology, in that it is about maintaining essential functions, which is rooted in ethics. This guides ecologists in the same way that the Hippocratic oath guides medical ethics” (Byck, p.c., 2014). Similarly, archeologist and founding director of the School of Sustainability, Charles Redman (2014) stated that the principles of naturalists are grounded in ethics, going beyond the values of the environmental movement.

Sustainability isn’t just an advanced form of environmentalism: it’s more anthropocentric and more about tradeoffs But the naturalists are tremendously important to sustainability. They have a systemic approach that emphasizes the maintenance of ecological functioning and a systemic approach that emphasizes interdependencies. Naturalists are also important because sustainability as covered by the naturalists is a moral code or ethic (Redman, p.c., 2014)

Finally, interviewees all seemed to agree that sustainability “must be about change” (Norton, p.c., 2014). This change must be based on the lessons learned throughout history, however. For “only in understanding our environment history can we envision our environmental future” (Cook, p.c., 2014). The term “sustainability science” suggests a more empirical worldview, but sustainability science, as is the case with the sciences in general, can never be value free (Norton, p.c., 2014). One respondent stated that, “the sustainability ethic is the need to leave things alone,” quoting from Ann Zwinger’s *Beyond the Aspen Grove* (1979) (Rudy, p.c., 2014). Many interviewees considered ethics to be an essential part of naturalists and sustainability theory that has yet to be delineated. Even environmental ethicists have argued that “ethicists haven’t said much about sustainability” (Meine, p.c., 2014), despite sustainability discourse being replete with inter- and intra-generational ethical decisions central to the *Brundtland Report*.

Sustainability Theory Question 2

Can naturalists teach us to think about the concept of sustainability in ways that the Brundtland Report (1987) and its three pillars can’t? There was a majority consensus that the concept *sustainability* needed to be “re-conceptualized” (Meine, p.c., 2014), if not “replaced” with other terms (Bill, Herzog, p.c., 2014). In fact, many suggested it “must” be or “inevitably will be” replaced although the name itself was not important (Herzog, p.c., 2014). They also agreed that the concept of sustainability needed to be “enhanced” or “re-thought” (Redman, p.c., 2014). Redman had no problem seeing the term fade out of practice, as the “name [sustainability] is problematic” because it has “no grounding” (Redman, p.c., 2014). Meine (2014) argued that it was a transient word. He preferred the simplicity of Leopold’s “land ethic” a short, non-partisan expression of natural-human systems that could appeal to anybody.

Herzog offered another alternative. “I much prefer the concept *resiliency* . . . many of the initial plans to form green networks of parks and projects were disregarded when Rio received the bid for the 2016 Olympics. Sustainability’s name is often associated with bad practices” (Herzog, p.c., 2014). As Herzog (2014) said of both sustainability and environmental thinking, “simply putting it into the construct is not enough.” Others also approved of resiliency as a new guiding theory as has been suggested by Salt and Walker (2012).

Bryan Norton (2014) also did not express an attachment to the term sustainability, despite titling his 2005 work, *Sustainability: Adaptive Ecosystem*

Management. In the book, he asserts the linguistic tradition of definitions must be mined to build a new vocabulary around sustainability thinking, which may, or may not, involve continuing the use of the term sustainability. Instead he argues for “thinking like a planet”—a concept he says his friend and colleague, the biocentric environmental philosopher J. Baird Callicott appropriated from him (Norton, p.c., 2014). While much of his writing revolves around Leopold’s contribution to sustainability thinking, Norton said, “The ‘land ethic’ doesn’t quite depict the atmosphere and oceans so I’m trying to conceptualize the ‘Earth ethic’” (Norton, p.c., 2014).

Many names offered as preferable alternatives to the name sustainability, such as “restoration ecology,” “conservation biology,” “resilience” (especially by international members like Bill and Herzog), and “land ethic” by Curt Meine who suggested that Leopold understood it correctly many years ago, use simple terms that everyone can support and that mostly avoid environmental partisanship. “Earth-ethic” and “Human and ecological wellbeing” (Santone, p.c., 2014) were used as terms to describe the goals of sustainability. “Agricultural sciences,” “experimental sciences,” and “urban planning” were used to describe the most important means by which we obtain sustainability.

Many based their thinking on the call for more integrative and transformational measures. Still others said that the name had not dominated discussions, especially abroad. Amber Bill, a forester from Wellington, New Zealand; Programme Manager for Our Living City; and author of the “Wellington City Council Biodiversity Action Plan” said,

When you say sustainability, I assume you mean environmental sustainability since the term sustainability is not big over here. I approached the subject as many have, by first conserving and then looking at deeper levels. I think a better three-prong approach [than *Brundtland* and UN-based literature] may be in what we use Nature/Society/Individual. (Bill, p.c., 2014)

When questioned as to whether *Brundtland* and the UN worldview could provide the transformational vision to achieve sustainability, most respondents said that the UN framework would not be able to do this by itself. Susan Santone, founder and director of the nonprofit Creative Change Education Solutions said, “The three pillars are too simplistic. Two of the legs of the stool are barely there,” referring to the social and the environmental pillars (Santone, p.c., 2013). She also reinforced the idea that UN-literature based frameworks are insufficient saying,

On the other hand, sometimes what you get is just what I call the ‘Green School Sandbox’ where they fail to look at the other dimensions at all. The three pillars concept is so ‘cookie-cutter’ and came out of the context of international poverty. Real development is a qualitative improvement, so we must question some of the assumptions of development, and focus on the well-being of people and the well-being of the environment. The commons is what supports well-being. But this calls into question, ‘what would that look like?’ *Brundtland* is too much *either/or* . . . (Santone, p.c., 2013)

As Julie Klein (2014), Professor of Humanities, English/Interdisciplinary Studies and Faculty Fellow in the Office for Teaching and Learning at Wayne State University; and author of *Interdisciplinarity: History, Theory, and Practice* (1980), and articles like Sustainability and Transdisciplinarity said, “[sustainability] needs to be clear about whether they are talking about economic sustainability or the sustainability of the planet. We need to get people thinking about the values, thinking in transdisciplinary ways.” She thought that the naturalists could help point us in the right direction.

Sustainability Theory Question 3

A naturalist stance is thought to be fundamentally preservationist. Is a preservationist stance incongruent with the UN concept of trading off between

ecological protection and economic growth and development? Most, if not all agreed that sustainability, both in theory and practice, seemed to be economically slanted. Some respondents linked tradeoffs back to economic growth. “The problem is that economic growth is a given,” said Santone (2013), reiterating some of the themes of this dissertation. But she added,

It’s very important to differentiate between development and growth. In the 1990s and 2000s, the size of homes increased tenfold due to the exurbs and increased urban sprawl. And tradeoffs for growth and jobs and what was considered progress have led to systemic problems that made the world very clearly much less sustainable. (Santone, p.c., 2013)

Tim Weiskel (2014) led me to research William Rostow-type economic thinking and development discourse [see Chapter Two] as the culprit. During the 1960s, this type of thinking looked at foreign aid as “an American narrative.” Weiskel (2014) described Rostow as one who promoted “economic takeoff” as an American export (Weiskel, p.c., 2014). “The problem was that he didn’t tell anyone where to land. This is precisely the kind of thinking,” he said, “that led to the high and unsustainable energy use we have today” (Weiskel, p.c., 2014).

Lynne (2014) suggested that the “transdisciplinary field of *ecological economics*” as the anecdote to the model of endless economic growth came out of the very practical and application oriented school of University of Florida. He argued in favor of the development of behavioral economics, a science he admittedly did not grasp until after he had received his doctorate, having been schooled in the classical economics tradition. Stating very simply that today’s modern economic system “represents bits and pieces of reality, but not reality,” he wished he had paid more attention to the behavioral economists in the beginning of his work, as that would ultimately guide a sustainable economic system. Naturalists, he said, tell us who we are, which possesses greater saliency and importance than identifying statistical and homogeneous human “trends.”

Lynne, in fact, called the way the “classical economic system” had been interpreted through American history “a straw dog,” and portrayed it as one-dimensional (Lynne, p.c., 2014). However, he warned against using Adam Smith as a straw dog for the model of endless economic growth. Smith, in fact, devoted a good portion of his writings to arguing for equity among economic partners as a sustainable means of ensuring a healthy economic system.

Sustainability Practice Question 1

How do we know when we can tradeoff? Given the current environmental crisis, is it ever justifiable to tradeoff our ecological resources? Interview results regarding tradeoffs were mixed. While each author acknowledged the inherent problems of trading-off, they differed as to whether it could continue to guide sustainability discourse. Redman (2014) suggested that tradeoffs were what defined sustainability; others were not so sure. Still others (Klein, 2014) asserted that SES problems “are so complex, there will always be tradeoffs.” The urban ecologist Edward Cook (2014) echoed Redman’s sentiment that trading-off is definitional to sustainability, especially in the city, making an important statement about tradeoffs by saying that “every actual project, whether conservation or preservation, is a compromise.”

On the core issue of when and what tradeoffs are appropriate, however, respondents often differed on the degree of the crisis and the level of preservation. For example, Weiskel (2014) stated, “Naturalists can address the problem because at its core the problem is fairly simple.” Redman (2014) was more cautious, “I wouldn’t turn it over to [the naturalists and ecologists],” he said, “Ecology often translates poorly to social science . . . ecologists make a series of sub-assumptions that social scientists can’t.”

Tim Beatley, author of many foundational sustainability books including *Resilient Cities: Responding to Peak Oil and Climate Change* (2009); *Biophilic Cities: Integrating Nature into Urban Design and Planning* (2010); and *Blue Urbanism: Connecting Cities and the Nature of Oceans* (2014), has been devoted to examining SES from the urban planning perspective. Contrary to Cook and Redman, he expressed the idea that,

As an overarching framework in which we *can* make tradeoffs, we must remember that a framework is an *overarching* thing and not expect it to be a *defining* thing. We can no longer tolerate thinking that it's just about cost-benefit analysis, and counting beans—then we've missed the point. Sustainability is about making tough choices. At the end of the day you might have to sacrifice part of that environment, but sustainability must also include the fact that there is intrinsic value in natural things, there is a sense of something beyond ourselves, and that there is great joy in connecting with nature. (Beatley, personal communication, 2014). In other words, the concept of sustainability is not clear and objective when it comes to tradeoffs, but tradeoffs do not need be the defining aspect of sustainability.

Although many respondents pointed to tradeoffs as part of the solution, many also would not deny that the concept of trading off was akin to *ideological polarization*. “We have a tendency to turn away from complexity under all conditions . . . it is easier to place ideas into dichotomies than to understand the nuances of a situation” (Redman, p.c., 2014). While ethical viewpoints seem to produce the most controversy among environmentalists and sustainability theorists, it is the scale and magnitude of anthropogenic-focused tradeoffs that are often most problematic in sustainability thinking.

All this leads to the conclusion that sustainability must be less about trading-off and more about transformational preservation of life-sustaining ecosystems (Weiskel, p.c., 2014). Many were adamant that “the economy must capture the true costs of the environment.” Klein (2014) remarked that in actual tradeoffs such as the Chitwan National Park in Nepal where extreme poverty exists outside a national park, the answer lies in “looking at sustainability on a small-world scale. Before the dams and the roads came, it was a viable system. We must preserve these systems and engage stakeholders in the coproduction of knowledge.” However, she thought that it was not yet very clear how this could be done in practice and how the moral dilemma between nature protection and human well-being should be navigated.

“Full-cost accounting” was one of the terms suggested (Santone, p.c., 2014). Respondents such as Beatley (2014) and William Rudy, a naturalist with MA and MS degrees in ecology from Brigham Young University who heads campus sustainability, replied similarly that sustainability should be “less” about trading-off because many sustainability solutions were win-win. Rudy (2014) echoed this sentiment, “We don't need to separate sustainability and aesthetics: if it's not beautiful, it's not sustainable.”

Sustainability Practice Question 2

Are there naturalists—or naturalist ideas—that have been detrimental to sustainability practices? Some sustainability scholars pointed out that not everything in ecology could be applied to the social sciences as easily as some naturalists suggest (Redman, p.c., 2014). Others observed that some naturalist cataloging and naming might have been negative as it “led to the control of environments, which could be dangerous” (Santone, p.c., 2013). Others stated that my four naturalists did not cover every important sustainable topic, like “biosecurity” for example (Bill, p.c., 2014). Many respondents—like Herzog, Meine and Norton (2014)—nevertheless had no problem with naturalists being the center of sustainability thinking.

One of the most interesting responses came from Cecilia Herzog, an Associate Professor in Landscape Architecture at Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio) and president and co-founder of Inverde Institute.³⁹ Her research is focused on biodiversity, water, and people in urban areas, and she is the author of *Cities for All: (Re)learning to Live with Nature* (2012). She invoked the 2014 Olympics in Rio again, which paved over many of the only natural corridors in the city. While social issues had made progress in Brazil, especially as far as legitimizing many of the poorer living quarters, many were still being cleaned out in the name of “sustainability” programs (Herzog, p.c., 2014). She said urban planning represented a field that was much more in touch with ecology; however, it could rarely produce benefits in a place with almost no urban planning.

In addition, Meine (2014) cited both past and present sustainability ideology as not being “palatable to certain groups,” such as agriculture in the 1980s. “Sustainable Agriculture’ in Iowa went belly-up,” he said (Meine, p.c., 2014). Peter Brastow (2014) said that individualism presents problems for sustainability because of the distinction between “self-determination” and “communal” in practice. “Case in point,” he continued, “many of the communal practices implemented in the China and Russia communist regimes following WWII that were designed to preserve the commons helped lead to their destruction.” He added that although “urban forestry” was now a popular term, it was not a practical philosophy to apply to all cities.

Redman (2014) partially implicated the naturalists saying, “The preservationist view of naturalists is fundamentally incompatible with sustainability Preservationists in the past have built metaphorical walls. While it is important to talk about what *can* be saved, it is more important to talk about what *must* be saved.” He also iterated that ecologists alone were not the answer as the ecological framework too often does not transfer to the social realm as easily as one would think (Redman, p.c., 2014). It “translates poorly to social science in practice . . . ecologists make a series of sub-assumptions that social scientists can’t.” He underscored this by this saying that we should frame sustainability around “ecological integrity” instead of preservation. “Academics love polarities,” as a way to describe what they see transpiring and then place things into theoretical constructs (Redman, p.c., 2014).

In contrast, Rudy (2014) evoked the *New Testament’s* references to “responsibility” toward the land, which included a deep, inherent sense of responsibility in the governorship of the Earth. We also discussed many passages about making the land healthy and references toward future generations, and he specifically evoked the Bible passage “let nothing be wasted” (*Bible*, 2002, John 6:12). Instead of being polarizing, Rudy saw religion as a uniting force, “spiritual ideas can be less complicated . . . Mormons believe that everything is living.” For instance, a “traditional Mormon village was one of communal practices,” Rudy (2014) said. In contrast, environmental historians like Donald Worster (1985) paint a picture of exploitation from these same practices.

Part of sustainability is breaking apart and resolving ideological differences and partisanship, differences that are largely the result of hierarchical understandings that place men over nature. Santone (2014) frames it as a “static hierarchy with ‘Man’ at the top of the food chain” that embraces the idea that “yeah, there are limits but we can overcome them with technology.” Norton pointed out that Thoreau, Carson, and Leopold were not so much preservationists as they were sustainability thinkers.

³⁹ INVERDE works directly with the President of Brazil in raising the awareness of the importance of green planning. Herzog has also published a book called *Cities for All: (Re)Learning to Live with Nature* (2013).

[These naturalists] would grab any ethical argument they could get their hands on and use it to be effective.... Leopold didn't feel he had to choose among arguments for nature or men, but that everything that we'd been doing was so damaging, the importance lay in changing our collective behavior" (Norton, p.c., 2014).

Sustainability Practice Question 3

Do naturalists have anything to teach us about wicked socio-ecological problems, and about seeing the Earth as one coupled system? Does the naturalist tradition have a "usable" or relevant scientific contribution in this tradition worth incorporating? Naturalists reportedly had the "fundamental principles" (Meine, p.c., 2014), but—like sustainability science—no single framework (Redman, p.c., 2014). Many sustainability scholars commented that sustainability must be about "place" (Beatley, Byck, Klein, Meine, Rudy, p.c., 2014). "If not local, than not sustainable," said Meine (2014). Rudy stressed throughout the course of the interview that naturalists had an inherent practicality toward our relationship with nature. He elucidated that those who did not understand ecology, quoting Scott Russell Sanders, make the mistake of "rooting themselves in *ideas* rather than *places*" (Rudy, p.c., 2014). He also said,

Science can be put into law. But it's about realizing the crows head back to the same spot everywhere just like you. We do this at a government-funded level but don't do it personally. It's a simple fact you can never build in a place that drains to a wetland, saying it was 'common sense,' but people can't see it. People also continue to build on the Utah fault lines The problem is that they haven't placed themselves in their environment. Leopold learned his place and realized where he is. He knew it was not about what to plant, but how to live life with consciences" (Rudy, p.c., 2014).

The *steward* and *citizen-scientist* concepts seemed to be among the most practical naturalist applications outside of the university upon which almost all sustainability scholars could agree (Bill, Weiskel, p.c., 2014). "Today's sustainability thinking is too complex. We need to go back to the ideas of conservation and stewardship" (Rudy, p.c., 2014). Each of these words conveys older concepts that have gained currency in recent years, and not just in America. Bill for instance suggested (without any prompting) that the American concept of sustainability needs a "citizen scientist" program like the one in New Zealand (Bill, p.c., 2014).

Garrett Hardin's (1968) view of custodian was evoked by two of the respondents who said that custodial values had been worked out by Eleanor Ostrom (2006) (Norton, Rudy, p.c., 2014). However, the naturalist from Brigham Young University cautioned, "being a custodian is not enough" (Rudy, p.c., 2014). Though he began by saying it was "not just about recycling" as seemed to be a common theme among smaller colleges at AASHE conferences, he delved into the larger mindset and observed how most people did not know what was happening even on the edge of their legal boundaries. However, he said recycling was essential because it was about "establishing new habits" and cited Leopold's *Round River* (1935) and the Biblical passage of "Dust to Dust" as an inspiration for recycling. He also pointed out that many people were not even educated on very simple practices, such as how developing uphill on a watershed would likely result in pollution issues for those downhill.

Sustainability Education Question 1.

Henry David Thoreau, Aldo Leopold, Rachel Carson, and Edward O. Wilson are iconic naturalists from four different eras of American environmentalism. What principles of naturalists are most relevant to a sustainability course? Which can be left out? Are there important ideas from other naturalists not covered by these four? Which naturalist (if any?) would you include/exclude from a sustainability course? Most

respondents emphasized the importance of ecology. As stated earlier in the methods section, although my selection of interviewees may have been somewhat biased, even those sustainability scholars who had never taken an ecology course had a tremendous respect for the field of ecology and naturalists. They seemed to emphasize their importance in sustainability discussions wherever possible.

For example, Bill McKibben, an environmental writer and climate-change activist who founded 350.org, which the *New York Times* calls the largest activist organization ever, emailed me, “Ecology—the idea that everything is connected—was the most fundamentally important discovery of the twentieth century, far more useful in the long run than atomic power. And of course it was really only a discovery in the West; it was taken for granted in older and deeper cultures” (McKibben, p.c., 2014). When asked which of the four iconic naturalists are most important to sustainability discussions and if there are important ideas from other naturalists not covered by these four, he replied:

They're all very important to any discussion of a workable world. Thoreau was a consummate naturalist and a natural activist; Leopold understood far better than Thoreau the importance of community (natural but especially human); Carson was the first person to really take the shine off modernity; and ‘Ed’ is not only the greatest scientist of the bunch (though Leopold gives him a run for his money) but also a powerful conservationist. (McKibben, p.c., 2014)

Almost all respondents agreed that the naturalists have proved important for their ability to articulate difficult scientific principles and their aesthetic value. Many thought that Wilson was the best scientist and Thoreau the worst. “Thoreau wasn’t trained as a scientist and wasn’t systematic . . . he was not really a naturalist” (Redman, p.c., 2014). But Norton’s (2003) reading of Thoreau clearly places him in an important place in the development of naturalism and ecology. Kellert said of Thoreau, “he played a different part in a different paradigm” (Kellert, p.c., 2014).

Some questioned if Carson should be considered a naturalist as she had gone into it “by accident,” and had both a “direct and indirect influence, becoming more important as the environmental movement progressed” (Redman, p.c., 2014). Michael Popejoy, a Harvard fellow researching Emerson and religion said, “There are two aesthetics—pleasure of the sunset, or scientific pleasure, a sensual experience of sunset versus the sun’s value to sustaining the complexity of the species. Maybe, we shouldn’t focus so much on the sensual aesthetics.”

Bill (2014) said that of the four naturalists, only Wilson was well known in New Zealand, and that practitioners there had been more influenced by local ecologists endemic to their country. Environmental ethicists Norton and Weiskel expressed skepticism regarding Wilson. “Wilson expresses a quasi-naturalist God . . . and is working from a position of power,” said Weiskel (2014), who has worked for Harvard University for over thirty years and is apprehensive of certain scholars achieving an almost demigod status. Klein (2014) said that although she respected Wilson’s scientific contributions, his theory of consilience was a “simplistic rendering” of transdisciplinarity and a “scientific fundamentalist explanation that ignores culture.” Kellert (2014) argued Wilson is the best scientist and may have the most important application to sustainable cities.

Norton (2014), who acknowledged that he had not carefully read *Consilience: the Unity of Knowledge* (1998), questioned Wilson’s (and others’) reductionist form of positivism, holding that society, like the physical world, operates according to general laws. He emphasized the definition in the *Oxford Online Dictionary* that states “. . . every rationally justifiable assertion can be scientifically verified or is capable of logical or mathematical proof, and that therefore rejects metaphysics and theism” (Oxford,

2014). Norton (2014) had this problem with the term *sustainability science* as well, saying it “creates a value-neutral description of the world, while what we need is a post-positivist assessment of environmental problems.”

Leopold was deemed by most to be an indisputable foundation of sustainability and the “closest to providing what we today call the three pillars” (Redman, p.c., 2014). This was supported throughout the literature reviewed as well. Kellert said of Leopold, Carson and Wilson:

The last three naturalists are very different but complementary naturalists and ecologists; one informs the other. It is unfortunate that the naturalist tradition is waning. Ecologists’ specialties get very reductionist and abstract, so it is very important to have an emotional connection. All three of those people had it. Wilson is different because his science is different. He is more of a scientist, more of a taxonomist and focuses on systematics. He is also an entomologist and specialized in social insects . . . but biophilia has not been well understood. Leopold was incredibly articulate. Leopold had a practical focus, a different kind of understanding, a great storyteller. All are good but Leopold is the best. He tried to weave together what I call the *narrative discourse* and *rational discourse*. Storytelling allowed him to do this and say things others could never say without the use of fiction.

With respect to the question of which additional naturalists or thinkers should be included in a sustainability course, interviewees suggested Lester Brown, Amory Lovins, and Bill McKibben (Redman, p.c. 2014); Vandana Shiva (Santone, p.c., 2014); David Edinburgh, otherwise mostly “endemic” and “national” naturalists (Bill, Herzog, p.c., 2014); and Scott Russell Sanders, Mary Austin, Tom Horton, Edward Abbey, John Burroughs—who “like Thoreau, . . . primarily investigated their own home” (Rudy, p.c., 2014). It should be noted these authors are found predominantly on the humanities side of the epistemological spectrum.

In general, Weiskel and Redman (2014) both agreed that naturalists, as Redman said, were “tremendously important” to sustainability education. “Naturalists are especially important in agency, as individuals inspire. The naturalists’ meta-narrative is so compelling and still relevant—there’s still a large public wanting to hear about interconnectedness” (Weiskel, p.c., 2014).

Sustainability Education Question 2.

What is the best way to teach all the skills required in the sciences, social sciences, and humanities to help solve today’s “wicked problems” (e.g. climate change, biodiversity loss, land health diminution) in a sustainability course? Most respondents suggested, or at least did not question, the idea of university reform across the board, especially a de-emphasizing of disciplinary work. Many said the university system needs reform. As Peter Byck (2014) said “silo-busting” is the common term for it, and the idea has been around a long time. He suggested, along with Redman (2014), that a differing reward structure is needed as an alternative to the current system that rewards increasingly specific levels of disciplinaryity.⁴⁰ When I interjected that there need to be generalists in academia whose job it is bring people together, this kind of “cross-fertilization,” Byck (2014) argued, needs to be taken outside of the four walls. “In the field” has been taken to be figurative for too long and should now be taken literally (Byck, p.c., 2014). Ecological fieldwork and scientific uncertainties also provide evidence that the idea that science is supreme is a myth, “Techno-boomerism’ and ‘Tinker Bell

⁴⁰ While this is an intriguing premise that is gaining recognition within academia, it is beyond the scope of this dissertation to explore possible alternatives in depth.

science' like that promoted by Walt Disney in the 1950s has dominated contemporary science, instead of asking, 'how do we adjust into the system we're born into,' which is a much more scientific question" (Weiskel, p.c., 2014).

There was some disagreement about whether ecologists should be at the center or merely part of sustainability. Suggestions included that we need to initiate ecology and biology as the core of science earlier in elementary school (Bill, Weiskel, p.c., 2014); that "ecologists should be paired with sociologists" (Santone, p.c., 2013); and that the most important element involved the scientific value of being "open-minded" (Bill, p.c., 2014). Regardless, naturalists were recognized primarily as environmentalists who can lead the big picture in the ecological and environmental sphere.

The majority believed that the basic principles of ecology should be more a part of our education, and that its basic principles should be taught at a much earlier age to provide new pathways into understanding coupled human-natural systems. The "ecosystem is the fundamental touchstone of sustainability" and what we must always return to (Redman, p.c., 2014). We "need to teach ecological science from the beginning, we aren't doing kids any favors by filling them full of technological advances" (Weiskel p.c., 2014). Popejoy (2014) also added, "naturalists show us the importance of personal and immediate experience. I would be skeptical about teaching sustainability without that."

Sustainability Education Question 3

Two frameworks for developing sustainability curriculum are (1) supplementing current ecology, economics, history, and other science, social sciences, and humanities courses, or (2) developing sustainability courses that integrate all relevant knowledge systems. How (specifically) would you include naturalists in either framework (1) or (2)? Most sustainability scholars believed sustainability principles should be *both* part of, *and* integrative with, traditional sustainability courses. Concerning the question that asked whether sustainability programs should be developed or whether sustainability should augment existing courses, almost all the respondents said that both were needed. As Redman (2014) points out, "interdisciplinary metrics are not well worked out." However, some seemed to think that there was appreciable integration among sustainability scholars, especially from the literature they had read from ASU faculty, and the School of Sustainability's mission encouraged them.

Many respondents did not offer viable mechanisms regarding how to incorporate the naturalists into sustainability education. Several suggested the reform efforts at ASU led by President Michael Crow was accomplishing this, while others believed that the lack of deep thinking about this question, makes it challenging to design a curriculum around sustainability that includes contributions from every discipline (Klein, Rudy, Santone, p.c., 2013-14). Those who were familiar with ASU's School of Sustainability program seemed to have faith that the courses offered through this program could provide these interdisciplinary pathways and expressed admiration for President Crow's efforts.

Summary of Results of Interviews with Sustainability Scholars

When questioned as to whether *Brundtland* and the UN worldview could provide the transformational vision to achieve sustainability, most sustainability scholars interviewed said that the UN framework would not be able to do this by itself. Susan Santone, founder and director of the nonprofit Creative Change Education Solutions said, "The three pillars are too simplistic. Two of the legs of the stool are barely there," referring to the social and the environmental pillars (Santone, personal communication, 2013). She also reinforced the idea that UN-literature based frameworks are insufficient:

On the other hand, sometimes what you get is just what I call the ‘Green School Sandbox’ where they fail to look at the other dimensions at all. The three pillars concept is so ‘cookie-cutter’ and came out of the context of international poverty. Real development is a qualitative improvement, so we must question some of the assumptions of development, and focus on the well-being of people and the well-being of the environment. The commons is what supports well-being. But this calls into question, ‘what would that look like?’ Brundtland is too much *either/or* . . . (Santone, personal communication, 2013)

As Julie Klein (personal communication, 2014), Professor of Humanities, English/Interdisciplinary Studies and Faculty Fellow in the Office for Teaching and Learning at Wayne State University; and author of *Interdisciplinarity: History, Theory, and Practice* (1980), and articles like Sustainability and Transdisciplinarity said, “[sustainability] needs to be clear about whether they are talking about economic sustainability or the sustainability of the planet. We need to get people thinking about the values, thinking in transdisciplinary ways.” She thought that the naturalists could help point us in the right direction.

Some respondents remarked that they found the interview questions too simplistic, “There is no silver bullet [for every sustainability issue],” said an interviewee. When questioned about trading-off, some said it should take a back seat to preservation, conservation, and restoration practices, but there must always be tradeoffs even in issues aimed at purely wilderness preservation. Reasons centered on the idea that surrounding every environmental issue there are always people with different views, approaches, and needs.

Sustainability Paradigm Questions

In this section on deep sustainability theory, I wanted to determine what sustainability scholars thought about the four selected authors—Thoreau, Leopold, Carson, and Wilson—as they relate to sustainability thinking. Interviewees were asked to place naturalists in relation to our cultural and environmental histories, the three pillars of the *Brundtland Report*, and the practice of trading off among the three pillars. Interviews established the relationship between naturalists/ecologists and UN-based literature as well as the general role of the four naturalists (see Appendix A. “Interview Questions,” questions 1-3).

There were three main findings of these interviews in the area of sustainability theory:

- i. environmental history and cultural history are important for understanding significant sustainability concepts such as *adaptivity*, *linking ecology and ethics*, and *context-based solutions*.
- ii. there are inherent problems in the accepted and received UN definitions of sustainability and sustainable development; sustainability may need a name change.
- iii. interviewees agreed that economic hegemony is common among sustainability frameworks in government, big business, and education.

For several reasons, naturalists were identified as part of the solution that could be used in addressing today’s ineffective, economic-based sustainability framework.. “Naturalists add another dimension, a really important element in sustainability” (Beatley, p.c., 2014). Another point concerns the manner in which naturalists have been viewed as humanists, who have made multiple contributions to many areas other than ecology. Because they were humanists and poets as well, naturalists were seen as “elegant at expressing the spectrum of values” where sustainability is concerned (Redman, p.c., 2014).

Theory of Sustainability Practice Questions

The application of sustainability principles is probably as important, if not more important, than sustainability's governing theory. After all, answering real-life problems is what sustainability is often said to be all about. Interview questions were therefore geared toward policy and practice-related problems of sustainability, focusing on the application of naturalists' principles and approaches to real-world problems.

Using these questions, I explored the relationship between trading-off within naturalist worldviews and the role of SES and resiliency theory in sustainability and wicked problem solving (see Appendix A. questions 4-6). Interviewees were asked how naturalist principles might be applied today to address wicked socio-ecological problems, or problems for which no one cause can be identified, are intrinsically linked with other socio-ecological problems, are not well defined, and are seemingly infinite in scope and scale. They were also asked to a) identify any principles that were not useful to sustainability discourse; and b) consider whether, the *preservationist* image of the naturalist tradition was congruent with the sustainability worldview of trading-off that developed out of *Brundtland* and other sustainability literature.

The summary of results for practice-related questions shows:

- i. ideologies, such as environmentalism, are very problematic but almost unavoidable. Depending on the scale and context, they can lead to inadequate practices, such as tradeoffs.
- ii. misunderstandings and misinterpretations of sustainability and sustainable development concepts often leads to misapplications of its principles; and
- iii. sustainability practice only succeeds with a deep understanding of problems and principles, and the application of nuanced and capacitated sustainability concepts such as *community stewardship*, *transformation*, and *long-term planning*.

Respondents were familiar with the long history of opposing ecocentric and anthropocentric visions for sustainability; yet, they rarely chose to identify themselves with the latter. Finally, most recognized that the naturalists had contributed significantly to the understanding of coupled systems (or SES).

"Naturalists have a lot to contribute to policy and practice" (Kellert, p.c., 2014). Nevertheless, sustainability scholars often disagreed on what this would entail. For instance, many were adamant that ecology must guide practices. Tim Weiskel (2014) stated, "Humans *can't* run the system." Others were just as certain that humans "*must*" run the system (Lynne, Redman, p.c., 2014). The decoupling and "disconnect of ecology and economics" that began with the Industrial Revolution and transformed the world economy, also changed the worldview to one of natural resources as fuel for the economy only. This was exemplified by Norton (2014), who remarked that our country had relied on natural resources for national security since at least WWI and the 1920s.

Sustainability scholars were acutely aware of the magnitude and nature of the sustainability issues as defined in the first chapter of this dissertation, and were well versed on the breadth of contemporary sustainability theory. For instance, Weiskel (personal communication, 2014) called for a much more transformational sustainability:

The crisis in Fukushima initiated a complete unraveling of the food chain, the outcomes of which we cannot even know; the legal system cannot even keep up with it. Meanwhile the U.S. races to buy up old missiles creating a stockpile of waste. As the result of environmental stressors, we are experiencing a period of extraordinary social stress. The soil of Egypt is now so salinized it has been declared 'ungovernable' over the

next decades. We [Americans] have a suicidal energy policy, and Washington is going in the exactly wrong direction. As a result, more and more people are decentralizing and living off the grid.

In fact, it is often not ideas or frameworks but actual events such as these that have actualized the landmark progress for the environmental movement so far, such as those that inspired activists such as Lois Gibbs (Love Canal) and Bill McKibben who have responded to dauntingly real and profoundly problematical environmental issues (Norton, p.c., 2014). In the next section, I explore how naturalists' theory and practice explored in these last two sections apply to education.

Sustainability Educational Theory Questions

This section probed mechanisms for applying environmental and cultural histories, as well as how to teach the requisite skills needed to solve today's sustainability and wicked socio-ecological system (SES) problems. While many interviewees had not explicitly stated previously that education was the problem, when we arrived at this set of questions they seemed excited that we were now reaching the root of the problem. Many respondents thought education had mostly failed at transmitting sustainability principles to date. Education, as Gary Lynne (2014) said, has helped keep things in "business as usual" mode.

Specific goals of this section included identifying the role of natural history and philosophy in sustainability education, and the role of naturalists' and traditional ecologists' principles in university undergraduate programs. From the interviews, I derived findings in three main areas:

- i. ecologists and naturalists should have a major guiding role in undergraduate education, as well as all levels of education in general;
- ii. ecology rather than technology should be the basis for teaching sustainability; and
- iii. university (and municipal) reform should de-emphasize silo-based, disciplinary work in long-term for sustainability planning.

I also asked sustainability scholars about two different types of sustainability curricula for the undergraduate level—a model in which sustainability theory and practice supplements existing educational structures and courses; and one in which a sustainability program integrated the most relevant and important parts of science, social science, and humanities in a new a comprehensive way (see Appendix A. questions 7-9).

Almost all respondents seemed to agree that naturalists and ecologists have been, and still are, essential to sustainability education and that their importance cannot be overstated. But, not all of the respondents agreed on every point. Many, in fact, disagreed on what the greatest contributions of naturalists were to the formal study of sustainability from which naturalists seem to be almost totally excluded.

Redman and Bill (2014) agreed, for example, that naturalists could add environmental and social aspects to sustainability thinking, but that naturalists could not contribute to the contemporary economic sustainability discourse. Some respondents argued instead that naturalists were most important to sustainability circles for their contributions in helping decide the sociological and cultural aspects. Still others, often practitioners, said they "haven't looked into" whether *Brundtland* and UN-related literature had too much effect on sustainability thinking (Bill, p.c., 2014).

Before providing some concluding remarks in the final chapter, here, I summarize systems naturalist principles and their implications, followed by a defense of a sustainability curriculum based on systems naturalist principles. Now that I have thoroughly examined how the naturalists produce three holistic principles of deep

sustainability theory, linking sustainability theory to practice, and sustainability educational theory (i.e. paradigm, practice, and pedagogy), this chapter will more thoroughly synthesize the three principles and axioms of previous sections and present dissertation outcomes as a whole.