

## Conservation of Biodiversity and Values – Gregory S. Keller

### Introduction

The broad field of science adheres to a specific well-established approach, emphasizing hypothesis testing while maintaining neutrality and detachment from the process. Historically, researchers saw themselves outside the realm of nature, with subjects of study unaffected by the researchers' presence. A value-laden approach has not been common in science, where scientists endeavor to maintain strict objectivity. However, an applied field that emphasizes practical solutions to scientific findings often invokes value-laden or mission-driven approaches. For example, oncology and AIDS research are both applied fields with a mission to not only understand these diseases, but also to actually cure devastating medical conditions. In the 1980s, a new and unique field of science appeared with a strong value-laden approach and an ecologically-based mission to reduce the devastating impacts of human-induced loss of biodiversity. Like oncologists or AIDS researchers, conservation biologists are devoted to solving practical problems. Although research in this field is as subjective-free as other sciences, conservation biologists are commonly advocates, using normative judgments and moral arguments to drive the field forward (Barry and Oelschlaeger 1996). In this way, conservation biology pushes beyond environmental ethics by actually applying value judgments to conserve species. Although this field is scientifically valid, the public must be convinced that value assigned to biodiversity by conservation biologists is itself also valid. Some public hesitancy about conservation of biodiversity may be the result of this field's reliance on evolutionary biology, which may have a stigma of historic debate and controversy, perhaps negatively tainting public attitude about science in general. In this paper, I will explore the nature of value judgments as they relate to the general field of conservation biology and the specific study of biodiversity loss; I hope to determine if a materialistic approach to biodiversity conservation is adequate, or if instead a religious or spiritual perspective either complements or actually diminishes the value placed on biodiversity. In addition, I will address the linkage between

the field of conservation biology and the practical application of evolutionary biology, noting how this relationship may negatively influence the value that the public puts on biodiversity.

### **The Field of Conservation Biology**

The field of conservation biology is at its core a mission-driven and value-laden science. The overarching mission of this inclusive subdiscipline in biology is to maintain high levels of endemic biological diversity (biodiversity) and reduce or mitigate human impacts that negatively impact biodiversity. Although the public often equates species richness with biodiversity, this term actually includes multiple levels in the scientific hierarchy. Loss of biodiversity can include loss of species, but it also includes more subtle impacts (loss of genetic diversity) and broader-scale impacts (loss of ecosystem functioning). These three levels clearly are linked together, and each level may be impacted by humans. However, each level also requires a different emphasis and a different type of management.

Much like the oncologist or AIDS researcher attempts to positively influence human health (an inherently good effort), the conservation biologist attempts to positively influence ecological health. Conservation biologists understand the ecological value of different species and necessarily assign different worth based on several criteria. Not all species or populations are equal from an ecological perspective (Soulé 1985). As an indication of the importance of the three levels in biodiversity, conservation biologists consider the genetic diversity in a population, the unique species richness of a community, and the ecological interactions and functions of a species. Specifically, as a value-laden science, conservation biology recognizes the inherent worth of intact systems, self-sustaining systems, ecological complexity, and intact native biodiversity (Soulé 1985). In contrast, scientists attempt to limit fragmented systems, systems requiring constant attention or artificial inputs, and practices that reduce biodiversity. A population that contains a unique genetic composition or that is large and ecologically functional has greater relative value. Conservation biologists also hold that rare species with fewer populations (closer to simultaneous extinction) are more “precious” than common species with multiple and robust populations.

Extent of habitat fragmentation (short-term division of habitats) and habitat loss (long-term reduction of habitat) are major predictors of the decline and extinction of native biodiversity and are recognized as the greatest threat to biodiversity (Wilcove et al. 1998; Brooks et al. 2002). Habitat fragmentation and loss affect all levels of biodiversity (genetic, species, and ecosystem) and lead to extinction in all habitats (e.g., tropical rainforest, deciduous forest) and geographical regions. Habitat fragmentation and loss are the result of human intrusion into natural ecosystems and lead to reduction in the overall amount of remnant habitat, isolation of remnant habitat patches, and reduction in the sizes of remnant habitat patches (Adrén 1994). In addition, with fragmentation of habitat comes fragmentation of populations; populations tend to decline in size with a restriction in habitats, often leading to extirpation (local extinction) of populations. Populations become isolated from each other, potentially restricting their viability and dispersal abilities and reducing gene flow and genetic viability.

### **The Biodiversity Crisis**

Loss of biodiversity occurs at a typical background rate as species become rarer or maladapted for a given set of environmental conditions. This rate has been calculated as approximately one species lost every four years (Convention on Biological Diversity 2001). Conservation biology does not inform us about the detrimental value of this natural background extinction. Extinction is viewed as a natural component of any ecosystem over time, typically balanced by speciation, defined as the mechanism by which new species arise by cladogenesis (splitting of a lineage into multiple species). However, the growing rate of anthropogenic-based extinctions is increasing exponentially and is recognized as devastating natural communities and ecosystems. Anthropogenic extinction rates continue to increase, biodiversity losses build to unimaginable levels, and speciation rates cannot keep up with these losses. Approximately 25% of vertebrate species, the most studied and most conspicuous species on earth, are endangered with extinction (Daugherty and Allendorf 2002). Other groups are likely going extinct at much higher rates, but fewer researchers study these taxa, and most extinctions are occurring in areas with limited scientific study (e.g., the Neotropics). E.O. Wilson (1988) and others anticipate that the

current loss of biodiversity will rival that of major extinction events at the ends of the Paleozoic and Mesozoic eras.

Such information represents a significant challenge to both conservation biologists and laypeople. If biodiversity has value and is critical for human survival, if biodiversity is being lost at a rate documented only during previous mass extinction events, and if human intervention is required to avoid continued losses, a natural response is that humans should act to stop losses and preserve remaining biodiversity. However, Barry and Oelschlaeger (1996) note that conservation biologists are misguided if they believe that simply providing knowledge to others will encourage conservation or reduce the biodiversity loss that is now occurring. If they are correct, conservation biologists require different emphases than figures, facts, and simple pleas to the collective minds of citizens to conserve biodiversity. Although scientists often are uncomfortable stepping from the objective value-free realm, using value judgments to highlight conservation may be a more productive approach to biodiversity preservation. In other words, rather than documenting population declines and species extinctions then sharing them with the public and expecting a response, conservation biologists may be more successful in illustrating the potential value of species and leading the public to a broader understanding of biodiversity. Therefore, I will now consider the value of biodiversity and the concomitant response to species extinction by the public in general and Christians specifically.

### **Materialistic Value of Biodiversity**

A central focus of this paper is the value placed upon biodiversity itself. Conservation biologists as a group understand that “biotic integrity has intrinsic value, irrespective of its instrumental or utilitarian value” (Soulé 1985:731). But is this an argument that will lead to conservation efforts appreciated by citizens responsible for supporting conservation efforts financially? Furthermore, is a materialistic approach adequate for conservation of declining, threatened, or endangered species, or do other perspectives, such as theological or religious perspectives, inform us?

Biodiversity can be valued for a variety of reasons, including the materialistic or economic benefits and indirect ecological benefits. Agriculturally and economically, biodiversity is the food, fiber, timber, and fresh water of our industrial society. Biodiversity can increase crop yield; infestation of fruit by insects such as the coffee berry borer (*Hypothenemus hampei*) was 1–14% lower on coffee plants with predation by birds than plants in enclosures (Kellerman et al. 2008). In this case, greater avian biodiversity resulted directly in increased yield. Pollinator services also are considerable, particularly in developing countries. Ashworth et al. (2009) found that nearly 85% of plant species that are consumed (i.e., fruits, nuts, or indirect food production) by humans depend to some degree on pollination by native species, including declining species of bees.

Furthermore, from a medical perspective, native plants are the common original sources of medicinal treatments (Balick and Mendelsohn 1992). Cragg and Newman (2004) note that 60% of anti-cancer treatments currently in use are derived from natural sources, primarily including plants, but also bacteria and marine species. The fields of ethnobotany and ethnomycology continue to drive research and development in the pharmaceutical industry. From a strict materialistic perspective, valuation of biodiversity has significant and long-lasting positive effects.

Conservation biologists understand that potential exists for even more discoveries of species that positively impact agriculture and medicine and therefore argue for conservation of all species on the basis of future economic benefits. However, a possible response by the public is that biodiversity that provides us with a current benefit should be preserved, but other species do not deserve our attention. Furthermore, DeWitt (1998) notes that with an materialistic approach to conservation, the market, “rather than serving as a means for stewardship, has been elevated to the arbiter of our personal and global ethics, with the result that human beings are divested of their role of stewards of creation and are seen as mere consumers of creation.” In other words, a discrepancy may exist between an materialistic value of species with currently known benefits compared to materialistic value of species with possible future benefits in the public perception. Therefore, we may require additional perspectives to fully persuade the public to value all biodiversity and support broader conservation efforts. Conservation

biologists must be comfortable shifting the dialogue of biodiversity conservation into a value-laden discussion based on ethical or religious perspectives that transcend materialism.

### **Ethical Value of Biodiversity**

Faced with unconvinced politicians, businesspeople, or church congregations, conservation biologists are often forced to find value not just for species that provide specific benefits to humans, but for all species in the web of life. We often turn to the ethical considerations of environmental ethicists and philosophers. The idea of a greater value than strict materialism in biodiversity (as “nature”) is not new. Focusing specifically on the past two centuries in North America, several examples exist of critical thinkers who found innovative reasons to either reject the materialistic approach or emphasize the ethical value of biodiversity. John Muir, Henry David Thoreau, and Ralph Waldo Emerson are commonly held up as great thinkers who all emphasized some aspect of the grandeur of nature, insisting that nature is a place to commune with a higher being and achieve religious transcendence (Callicott 1990). Although considerable differences exist in the approaches and backgrounds of these philosophers and writers, they typically shunned early industrial development and (over) use of natural resources in favor of strict and passionate preservationism, such as that advocated by Næss and Rolston. A preservationist approach emphasizes an intrinsic value in the natural state with an attitude to let the land be. As evidenced by the great detail in descriptions of species in Thoreau’s work, an aesthetic appreciation of the natural world provided substantial meaning to preservation. Illustrating the beauty of nature and the majesty of aesthetic value, Thoreau wrote: “I was reminded, this morning before I rose, of those undescribed ambrosial mornings of summer which I can remember, when a thousand birds were heard gently twittering and ushering in the light, like the argument to a new canto of an epic and heroic poem. The serenity, the infinite promise, of such a morning!” Their words and thoughts still inform modern thinkers and conservation biologists.

However beautiful the words and inspired the thoughts, their approaches to save nature through a preservationist approach has a significant shortcoming as we consider biodiversity. Specifically, a

preservationist approach emphasizes the status quo with limited or no human intrusion, attempting to separate the scientist, ethicist, and public from the pristine system. The danger of this approach is that it attempts to maintain an unrealistic standard; there is no pristine system, and efforts to limit human impacts on biodiversity must also encourage adaptation by species.

In a shift from materialism and a twist from strict preservationism, Aldo Leopold (1949), a devoted and energetic wildlife biologist, detailed the role of biodiversity. He proclaimed, “The last word in ignorance is the man who says of an animal or plant: ‘What good is it?’” Further, Leopold noted that “If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.” This sentiment, the value of biodiversity regardless of our understanding of its ecological role or economic promise, emphasized a significant response to the strict value of biodiversity as resource in the early 20<sup>th</sup> century. Although Leopold commonly advocated passive preservationism, Callicott (1990) stated that Leopold’s view of ecosystems as both “economically productive and ecologically healthy” may provide the best hope for conservation biology.

### **Religious Value of Biodiversity**

For many conservation biologists and environmental ethicists, valuing biodiversity in light of both intrinsic and extrinsic benefits is enough to claim the worth of conservation. For an ecologist, loss of ecosystem functioning with loss of biodiversity, particularly through population declines of important keystone species (i.e., a species that has a disproportionate impact on an ecosystem), is an adequate argument to satisfy conservation efforts. For an environmental ethicist or philosopher, the inherent rights of species or an appreciation of biodiversity as nature spark the desire to support efforts to conserve biodiversity. However, to persuade nonscientists or people outside of academia, is more required? Must conservation biologists move beyond a strict materialistic or ethical perspective to convince the public of biodiversity value? Furthermore, is an materialistic approach adequate for conservation of declining, threatened, or endangered species, or do theological or religious perspectives

(specifically a Christian perspective for the purposes of this paper) inform us more deeply and convincingly? I believe they can, but this approach is fraught with difficulties.

A basic reading of the Bible illustrates the Christian call to value biodiversity in the form of Creation. The book of Genesis abounds with value statements. The Lord God saw that Creation was good throughout the creative process itself. Genesis 2:15 states “The Lord God took the man and put him in the Garden of Eden to work it and take care of it,” a message that Creation has worth and requires human care. An ethical consideration of the rights of other species is illustrated in Psalm 148: “Mountains and all hills; Fruit trees and all cedars; Beasts and all cattle; Creeping things and winged fowl...Let them praise the name of the Lord, For His name alone is exalted.” Although debated for its meaning and authenticity as an event or allegorical story, Noah’s ark and the associated flood have been used as modern messages to preserve species found on earth (DeWitt 1998): “You are to bring into the ark two of all living creatures, male and female, to keep them alive with you. Two of every kind of bird, of every kind of animal and of every kind of creature that moves along the ground will come to you to be kept alive. You are to take every kind of food that is to be eaten and store it away as food for you and for them.’ Noah did everything just as God commanded him” (Genesis 6:19-21). Finally, the message of sustainability is a common theme both in conservation biology and the Bible. Deuteronomy 22:6-7 emphasizes this message very clearly: “If a bird’s nest happens to be before you along the way, in any tree or on the ground, with young ones or eggs, with the mother sitting on the young or on the eggs, you shall not take the mother with the young.” Although this list is short and a relatively superficial representation of a few verses, I believe the message is clear that Creation should be valued, that Creation can be valued materialistically, aesthetically, and ethically, and that Christians are mandated to care for Creation. So if the term biodiversity can be substituted with the term Creation, the natural but enormous question becomes why aren’t Christians doing so? Several groups are doing so. The Evangelical Environmental Network ([www.creationcare.org](http://www.creationcare.org)) “seeks to educate, inspire, and mobilize Christians in their effort to care for God's creation, to be faithful stewards of God's provision, and to advocate for actions and policies that honor God and protect the environment.” Another group, The

Noah Alliance ([www.noahalliance.org](http://www.noahalliance.org)), states that “People of faith are called to care for God’s creation with its many creatures. Our Scripture instructs us to be good stewards of God’s earth. Our traditions and teachings tell us to protect the web of life. Our worship declares that the earth is filled with the glory of God (Psalm 72:19)... [In addition, we recognize that] the protection of species and their habitat is also vital to people’s well-being.” Such groups are an encouraging reminder that Christians can indeed be community leaders in caring for biodiversity. However, typical members of many congregations seem removed from this approach and even hostile to these efforts (Wright 1995).

### **Religion versus Conservation Biology**

I believe a source of this distinctly Christian interpretation of environmental conservation is based on the interpretation of two portions of one key verse in Genesis. The King James version of the Bible, long trusted by the most conservative congregations, provides this translation of Genesis 1:28: “And God blessed them, and God said unto them, Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.” Other translations soften the language and replace the word “dominion” with “rule” or “reign.” Another commonly used term, “subdue,” also invokes control over the system by humans. First, from a casual reading, the use of the word dominion suggests to some that Christians have a right and ability to misuse, ignore, overexploit, and abuse biodiversity as they see fit. From a very conservative reading, as those with dominion, Christians expect species to adapt to their activities and bend to their wills. Importantly, many mainstream Christians believe this view is extreme and misapplied. Calvin DeWitt (1998) has been an evangelical leader in Christian environmental ethics and studies for decades. He notes that dominion as domination actually is forbidden, whereas dominion as stewardship is an interpretation of this passage much more concordant with the rest of scripture. This view of dominion, with Christians as caretakers (as illustrated above from Genesis 2:15), is the banner message stressed by Christians who are attempting to shift the evangelical tradition toward stewardship. The very question of biodiversity value by Christians hinges on this idea – we are not likely

to conserve what we believe we dominate. In contrast, if Christians are called have dominion as stewards, perhaps we may be successful in shifting public perception based on religious considerations. This message may be the key to conservation biology with Christian groups.

A second hurdle for conservation biology in this verse is the emphasis that humans be fruitful and multiply as a mandate from God. This verse has contributed to a pervasive attitude linked with the notion of domination that we should tame the wilds of nature for our own purposes to the exclusion of species that cannot survive with the weight of humanity. With a human population hovering just short of seven billion people, many scientists believe the earth is quickly approaching (or has even surpassed) its ecological carrying capacity (Cohen 1995). Overpopulation is commonly accepted by conservation biologists as the ultimate cause of most environmental challenges that we now face (Meffe et al. 1993), and global degradation from overpopulation is witnessed in all aspects of conservation biology.

Evidence of our potentially debilitating impacts on the Creation is abundant in the scientific literature. For example, Chown et al. (2003) found a positive statistical correlation between avian species richness and human population density. This relationship suggests that both humans and birds are influenced by primary productivity, drawn to the same locations of high productivity. Specifically, although many of these locations are maintained as conservation reserves, high human population density surrounding these reserves places the contained biodiversity under a greater threat to external pressures. Similarly, Cincotta et al. (2000) noted that global biodiversity hotspots are also centers of human population density, with 20% of the human population living within them. Such precariously high densities will likely lead to significant biodiversity loss in the near future. However, without acknowledging or even understanding the negative consequences that human population density or overpopulation can have on biodiversity, conservative Christians are likely to ignore the concerns expressed by conservation biologists about overpopulation.

Many Christians, particularly in the Evangelical subset in the United States, tend to be more skeptical about scientific claims than other groups (Nagle 2008). This mistrust of science likely stems from a long-standing mistrust of people who support evolutionary theory. A belief in evolution is often

used as a litmus test for doctrinal orthodoxy. This view colors their understanding of science in a variety of fields and likely extends to biodiversity conservation. If one does not believe in evolutionary science, one is less likely to understand ecological theory and all disciplines that stem from this theory. Wright (1995) has noted that an environmental backlash has included Christians ranging throughout the political spectrum, perhaps requiring the push forward to conserve biodiversity to move outside of the scientific arena and into the spiritual sanctuary.

### **Application of Evolution in Conservation Biology**

Evolutionary theory has an indirect but critical connection to the field of conservation biology. Evolution can be defined as a genetic change in allele frequencies over time in a population. This genotypic change may be evidenced as phenotypic (measurable morphological) change as well. The primary mechanism of evolutionary change is achieved through natural selection, resulting in adaptive population change.

Proponents of evolutionary theory note that natural selection has three requirements for adaptive change to result. First, the focal trait must have variation within the population; in other words, the focal trait must have more than one genotype. Second, the trait must confer an advantage to those individuals who carry it compared to those who do not, either resulting in increased survival or greater reproductive output. Finally, the trait must be heritable, passed from parent to offspring. If these three requirements are met, natural selection leads to adaptive change in a population over time.

As a practical and mission-driven field, conservation biology is concerned very little with historical animosity concerning the evolution debate. In contrast, conservation biology takes a very different approach asking the question, “Are species given the flexibility to evolve in the future?” With high human population densities, extensive habitat fragmentation and loss, overexploitation to meet human needs, introductions of non-native species, and exposure to novel environmental conditions, most native species are influenced negatively by all that humanity has wrought on the earth (Stockwell et

al. 2003). However, if species have genetic flexibility, we may envision a limited loss of species diversity if these losses are ameliorated with evolutionary change.

### **Challenges to Christians and Conservation Biology**

Recent surveys have exposed the obstacles to the understanding of evolution in the United States that conservation biologists must overcome. First, Waltke (2009) explored the understanding and acceptance of evolutionary theory by an interesting group: evangelical seminary professors. Responses from this group are intriguing, because these professors represent conservative, intellectually-thoughtful evangelical Christians who typically “believe the Bible to be the inspired, the only infallible, authoritative Word of God” (Waltke 2009). Waltke noted specifically that 44% of respondents viewed the reading of Genesis chapters 1 and 2 as barriers to their acceptance of the possibility of evolutionary theory, whereas 46% of respondents accepted the possibility of the theory of creation by evolution. While he notes that these results are encouraging, as it signifies a possibility that evangelical Christianity and evolutionary theory can coexist, I find the results troubling. A large percentage of this learned group, including the professors well-versed in biblical understanding and responsible for training future ministers and heads of congregations, cannot accept such a possibility as evolution. With this barrier in place, is it possible for conservation biology to proceed and protect species from extinction? Second, Coral Ridge Ministries’ 2008 Annual Spiritual State of the Nation Survey recently reported that of 13,000 U.S. evangelical Christians responding to their survey, 85% viewed evolution as very dangerous to the well-being of the United States ([www.coralridge.org](http://www.coralridge.org)). Although this survey did not include questions about species conservation and likely surveyed the most politically and biblically conservative Christians on the spectrum, it also illustrates the unified and pervasive sentiment against evolution based on a misrepresentation of science in this demographic of society.

Another major challenge in our understanding of biodiversity loss is the imperceptively long temporal scale at which this loss is occurring. The public is bombarded daily with the striking images of dead fish, oil-soaked birds, and masses of dead jellyfish washed ashore after a major oil spill, as is

happening currently along the U.S. coast in the Gulf of Mexico. They respond to a short timescale where a catastrophic event leads directly to instantaneous loss of populations, significant decline of the fisheries industry and tourism, and a direct increase in the cost of crude oil. But the timescale of loss of species through habitat fragmentation is considerably different – decades or centuries of fragmentation lead to the slow decline of populations, perhaps ultimately resulting in extinction (Brooks et al. 1999). Yet the impacts are typically far greater and more long-lasting than a single catastrophic event. Dobson et al. (1997) noted that with long-term habitat loss, loss of biodiversity is exacerbated as degradation of ecosystems results in further extinction. Loss of species results in loss of ecosystem functioning, which results in further loss of species. The long-term impacts are truly long-term, and conservation biologists have difficulty convincing the public of the associated causes and effects over this timeframe. This pattern significantly affects value and concern.

However, Stockwell et al. (2003) noted that responses to habitat fragmentation may involve contemporary evolution, or evolution over the course of centuries rather than millennia. This recent view of short-term contemporary evolution from intense habitat fragmentation and loss may have an unintended consequence. Many evangelical Christians are young-earth creationists who believe in a strictly literal interpretation of Genesis and a 6,000-10,000 year age of the earth. If some (albeit limited) evolutionary change may occur over the course of several decades or centuries rather than the hundreds of thousands or millions of years typically considered necessary for evolutionary time periods, then time constraints are removed as potential hurdles to accepting evolution as it relates to biodiversity conservation. This may give a false sense of comfort that most species will be able to quickly evolve, when in reality the extinction rate is continuing unchecked.

In a response to the call by Calvin DeWitt for evangelical Christians to become stewards of Creation, Thomas Sieger Derr (1998), formerly a professor of religion at Smith College, stated his hesitancy to accept the evidence of global climate change; I think the message of complexity and ambiguity relates well to conservation biology. Derr noted that the public in general and Christians more specifically see discord among scientists that leads to a mistrust of any common message: “I

certainly get discouraged, as a layperson, when I see my scientific betters, sporting their Ph.D.'s and their prestigious appointments, squabbling over the meaning of their measurements.” Contrarians attempting to find a voice in the press are common (Wright 1995), but perhaps harder to identify by nonscientists for their true motives: publicity. In my nonmajors science classes, we address this difficulty as it relates to junk science, and I am regularly amazed at how easily students are swayed by anyone lacking scientific experience but willing to say loudly what the students want to hear about the environment. Derr (1998) continues: “We could document severe disagreement on the ozone hole, pollution, the loss of fertile lands and forests, loss of species....And as we have learned through a long and sometimes painful history, making judgments on the conclusions of natural science is not an area in which a specific Christian conclusion is readily available.” I absolutely disagree based on a subtle distinction commonly seen in conservation biology. Even though the public may not want these statements to be true, there is a measureable hole in the ozone, humans do produce substantial pollution, habitat loss is occurring at a significant level, and scientists have documented an incredible loss of species through extinction. I think it is disingenuous and incorrect to claim there is “severe disagreement” on these topics. What is absolutely debatable and value-laden, however, is the precise manner in which we solve these problems and the financial resources we invest in these solutions. But we cannot let these debates diminish the actual and well-documented impacts that humans have on natural systems. In doing so, we lose sight of the significant value, both intrinsic and instrumental, that species may have; in addition, we lose sight of conservation as an established science that provides context to biodiversity loss. Indeed, valuation of biodiversity will help inform not only the ways in which we solve these problems, but also the manner and speed with which we approach them.

### **Case Study in Conservation and Evolution: Ivory-billed Woodpecker (*Campephilus principalis*)**

I arrived at work the day the 3 June 2005 issue of *Science* was released amid a buzz of excitement: “Did you hear about this yet?” Such a question was significant, since the intersection of public relations and conservation biology, specifically ornithology, is very rare. Even more significantly,

the excitement came not from my fellow scientists, but from family members, non-scientist friends, and church members. The excitement centered around a discovery, or more accurately a rediscovery, of a bird (Fitzpatrick et al. 2005). On face value, such a rediscovery may have passed by without so much as a second glance by most people, including my family and congregation. But on this day, they could not wait to share the joyous news that was conservation biology at its finest; they had heard the reports of the rediscovery of a woodpecker so large and awe-inspiring that it was long ago dubbed the Lord God Bird, for its propensity to convert atheists to believers (Hoose 2004). The bird tended to evoke one response from all first-time viewers: “Oh Lord God...did you see that bird?” After a 60-year absence, the Ivory-billed Woodpecker had joined the ranks of other “Lazarus Species” as the Coelacanth (*Latimeria* spp.) and the Banggai Crow (*Corvus unicolor*), species thought permanently extinct until field researchers documented their persistence. Indeed, although still debated, researchers have changed the official Conservation Status of the woodpecker from extinct to critically endangered (IUCN 2009).

The following year, I trod through the deepest and most desolate regions of the continental United States in eastern Arkansas, surrounded by Tupelo (*Nyssa* sp.) and Bald Cypress (*Taxodium distichum*) trees with massive 4-meter wide trunks, and searched for any evidence of the woodpecker. During my two-week participation on the search team, I found myself hoping desperately for a sighting by my team while pondering the actual value of this re-emergence. I am convinced that even if this species still exists in the deep forests of the southeast, the conservation of this species and ultimate recovery is unlikely.

The problem for this species is not in the direct or indirect value imposed by humans. The Cornell Laboratory of Ornithology continues to send researchers to the White and Cache Rivers in an effort to document any evidence of the species (<http://www.birds.cornell.edu/ivory>). This attention to eastern Arkansas as a destination for ecotourism and scientific research has resulted in some level of recovery for a region with limited economic stability. Specifically, Brinkley, Arkansas, a small town at the center of media attention and in the heart of the Bible Belt, has embraced the potential finding, advertising The Ivory Billed Inn, Ivory-billed Woodpecker haircuts, and Ivory-billed Burgers at the local

barbeque in a clear nod to the materialistic value of this species. Although value of this species may not necessarily be based on a Leopoldian appreciation of the “cogs and wheels” of nature, it is highly regarded by residents. As an awe-inspiring bird of an awe-inspiring habitat, the Ivory-billed Woodpecker clearly represents an aesthetic value. However, its rarity clearly removes the ecological value of this species, as it no longer provides ecosystem functioning to this region. Finally, in this strongly religious region, a spiritual appreciation may be relevant.

In contrast, what will limit any potential recovery of this species is adaptation via natural selection. More directly, the application of evolutionary theory falls short with this species. As a species that requires extensive tracts of undisturbed bottomland forest, the Ivory-billed Woodpecker is highly specialized to consume very large beetle larvae (Jackson 2002). If it still exists, it no longer is a functional member of the ecosystem, given its incredibly low abundance. Furthermore, habitat has been reduced to 10% of the former extent. The Cache River watershed contains 200,000 hectares, a large area that is not capable of sustaining a sizeable population of woodpeckers. Ranging widely over the formerly widespread swamps, a single woodpecker required thousands of hectares of core habitat for foraging and nesting. Current reserves and protected lands are heavily fragmented, and limited core habitat (removed from human edges) exists relative to historic levels. Such a reduction is important for two reasons. First, habitat loss has directly led to loss of the species and indirectly led to reduction in prey abundance (Jackson 2002). Second, and more importantly, fragmentation has reduced the likelihood of movement among habitat patches, removing the possibility of this species being maintained as a metapopulation, with small subpopulations interacting and maintained by dispersal and immigration. If this species still exists in the wilds of southeastern U.S., genetic diversity is completely reduced, and the ultimate chances of genetic change via natural selection are unlikely. In other words, evolutionary change will not occur because of genetic reduction. Stockwell et al. (2003) stated that contemporary evolution due to habitat loss or fragmentation is “influenced by complex interactions among population size, genetic variation, the strength of selection, and gene flow.” With incredibly

small population size leading to limited genetic variation and with isolation among lowland forest remnants, the Ivory-billed Woodpecker does not have the capacity to adapt through natural selection.

This species has considerable materialistic value, generated from the original five-second video clip of a bird flying away, as recorded in the Arkansas swamps in 2004. Ironically, the town of Brinkley, with a motto of “We know they’re here,” has seen the development of a new convention center and industrial park based on the influx of visitors and searchers. Visitors to the region value the woodpecker from an intrinsic or spiritual perspective, with a goal of saving the species through preservation. Yet conservation is unlikely. Importantly, the true value of this species may be in the potential of “transferred” value – can a magnificent species such as the Ivory-billed Woodpecker lead residents and visitors to a greater appreciation of nature or a desire to conserve habitat for other declining, threatened, or endangered species in the White and Cache River watersheds? This may be the truly great legacy of the Lord God Bird in conservation biology.

### **Final Thoughts**

In 2006, my graduate student and I published a paper that considered the limited participation in the field of conservation biology and mechanisms to advance research in this field from faculty and students at small colleges and teaching universities (Keller and Avery 2006). As an educator, I stressed the primary solution of education: teaching both majors and nonmajors about the field of conservation biology, involving them in conservation research, and most importantly, focusing on education of nontraditional groups, such as community associations and college administrators. I recognize now that it was a significant oversight to overlook evangelical Christians in this group.

Calvin DeWitt has noted that God’s words (the Bible) and God’s works (Creation) both speak to our understanding of the world, including the value we assign it (in McKibben 2006). Historically, Christians have emphasized our biblical understanding to the exclusion of our understanding of Creation. We may consider our deeper understanding and appreciation of natural and ecological processes a way to glorify God, making our lives richer and more meaningful. More practically,

educating Christians through Bible studies, adult and children Sunday school programs, and pastor enrichment and education courses may result in individual (but significant) shifts in worldviews over time. In particular stressing the loss of biodiversity and the decline of ecosystems, noting the possible harmony of natural processes with biblical insight, may help shift attitudes and value systems.

Regardless of the value gained from biodiversity as strictly materialistic, ecological, aesthetic, or religious, we as conservation biologists must turn to new partners and use any reasonable approach to limit further loss of genetic variation, species diversity, and ecosystem functioning and to help redeem nature, Creation, and biodiversity.

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