J. Raptor Res. 26(3):179–183

CONSERVATION BIOLOGY AND THE EVOLUTION OF A LAND ETHIC

DALE E. GAWLIK
Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843

ABSTRACT.—"Conservation biology" is reportedly distinct from other natural sciences because of its focus on a wide array of biota, the long-term scale at which it operates, its holistic nature, its assumption that organisms have an intrinsic value and its direct application of research to a management goal. However, most of what contemporary conservation biologists endorse was previously proposed by Aldo Leopold, and practiced by two of his former students, Frederick and Frances Hamerstrom. That their work with Northern Harriers (*Circus cyaneus hudsonius*) and Greater Prairie Chickens (*Tympanuchus cupido pinnatus*) has received widespread recognition is a testimony to the effectiveness of this approach. Conservation biology is only now gaining widespread acceptance probably because of the increasing importance that society has recently placed on the environment. Leopold predicted that society's perception of the environment would move towards what he termed a "land ethic" before the approach endorsed by contemporary conservation biologists could be successful. We may be witnessing the stirring of just such a movement.

Biología de la conservación de la naturaleza como un paso en la evolución hacia una "Ética en el uso de la tierra"

EXTRACTO.—La biología de la conservación de la naturaleza es referida como distinta de las otras ciencias naturales; esto es así debido a su enfoque de una amplia gama de la biota, la escala en la que opera, su naturaleza todista y compleja, su asunción de que los organismos tienen un valor intrínseco, y la aplicación directa de sus investigaciones a los objetivos conservacionistas. Sin embargo, la mayor parte de lo que los biólogos conservacionistas contemperáneos rubrican fue previamente propuesta por Aldo Leopold, y practicado por dos de sus discípulos Frederick y Frances Hamerstrom. El trabajo de ellos, con aves de las especies *Circus cyaneus hudsonius, Tympanuchus cupido pinnatus,* ha recibido amplio reconocimiento, lo que es un testimonio de la efectividad de este método. La biología conservacionista, solo recientemente, está ganando amplia aceptación probablemente debido a la creciente importancia que recientemente la sociedad está dando al medio ambiente. Leopold ha pronosticado que la percepción ambiental de la sociedad ha de encaminarse a lo que él llama "Ética en al uso de la tierra," antes de que el método seguido por biólogos conservacionistas pueda tener resultados con éxito. Quizás estemos testimoniando la animación de tal movimiento.

[Traducción de Eudoxio Paredes-Ruiz]

The term "conservation biology" describes a new and developing field with a unique focus and approach to addressing conservation problems (Soule 1985). The emergence of the Society for Conservation Biology in 1985 (Soule 1987) and the rapidity of its acceptance in the biological sciences clearly suggest a real need for the group. A review of the early literature reveals that conservation biology as an approach to biological problems emerged almost 50 years earlier when Paul Errington and Frederick Hamerstrom (1937) described their profession of wildlife management as "the new and growing field of conservation biology." Subsequently, in a chapter in his Sand County Almanac entitled "The Land Ethic," Leopold (1949) discussed the philosophical justification for this approach and predicted its staged development. Here, I develop the argument that contemporary conservation biologists follow the approach of Leopold and his former students, Frederick and Frances Hamerstrom. I provide support for this notion by examining Leopold's "Land Ethic" for the underlying theme of conservation biology, and by tracking his ideas through case studies including the Hamerstroms' work on Greater Prairie Chickens (*Tympanuchus cupido pinnatus*) and Northern Harriers (*Circus cyaneus hudsonius*). I also address the question as to why conservation biology is only now gaining widespread acceptance, and discuss the pivotal role of society's perception of conservation.

CHARACTERISTICS OF CONTEMPORARY CONSERVATION BIOLOGY

Contemporary conservation biology is said to be on the interface of science and policy, and as such is frequently referred to as a crisis or mission-oriented discipline that incorporates both science and art (Soule 1985). The primary goal of the discipline is to preserve global biological diversity (Soule 1985, Gavin 1986, Murphy 1990).

Soule (1985) included the following characteristics in his definition of conservation biology: 1) its belief that biological resources have some inherent value beyond that of economic gain, 2) its focus on a wide array of biota, 3) the scale in which it operates (e.g., goals are often stated in terms of long-term viability rather than short-term production and maximization), 4) its holistic approach both to the level of study (i.e., it focuses on communities, systems and processes as well as species) and to the participating disciplines (i.e., it relies on social sciences, economics, philosophy, earth sciences and biology), 5) the direct application of its research toward management (Murphy 1990).

THE LAND ETHIC AS A FRAMEWORK FOR CONTEMPORARY CONSERVATION BIOLOGY

Leopold (1949) described conservation as the ability to understand and preserve the capacity of the land for self-renewal, and as "a state of harmony between men and the land." Leopold used the term "land" to represent all things, biotic and abiotic, associated with the earth. He realized that humans must exist as an integral component of the land rather than apart from it as a separate entity. Indeed, changing people's perception from one of "conqueror" of the land to that of "member" is the essence of the "Land Ethic."

Contemporary conservation biologists warn against an anthropocentric view wherein the value of a biotic community is determined solely on economic grounds (Soule 1985, Callicott 1986, 1990, Norton 1988, but see Kellert 1986), and where conservation efforts would therefore be necessarily restricted to relatively few species. This contrasts sharply with that of most conservationists during the early 1900s when natural resources were viewed as commodities to be consumed by all (Callicott 1990). Indeed, it was under these prevailing conditions that Leopold was trained as a forester and subsequently employed by the U.S. Forest Service (Meine 1988) to implement production-oriented management practices. Leopold crystallized many of his ideas in his book "Game Management" (Leopold 1933). Although the title suggests an exclusive orientation toward economically important species, Leopold (1933) suggested that the objective of both game and nongame management should be to allow people the opportunity to admire and enjoy all types of wildlife. Leopold (1949) further articulated his belief that a biotic community composed solely of economically important species could not function properly. He stated that economically unimportant species "are members of the biotic community, and if (as I believe) its stability depends on its integrity, they are entitled to continuance." He explicitly reminded us that all members of the biotic community are valuable because it is their membership that defines and perpetuates the functioning system. Each member, therefore, has an intrinsic value not necessarily related to its use to humans. As a closing comment on the subject Leopold (1949) cautioned that economics must play a role in defining the limits of land use, but it is imperative that economics not become the sole determinant of all land use. He suggested this would be the greatest obstacle to the development of a land ethic.

Leopold (1949), like contemporary conservation biologists, shared the belief that to be effective conservation must be multidisciplinary. He recognized that education can provide the basis for an understanding of the land, yet he was not satisfied with what higher education was providing. The idea that ecological knowledge was simply obtained through the study of ecology ran counter to his broad approach to conservation. Specifically, he believed it was proper and necessary for ecologists to be trained in economics, history, geography, botany and agronomy.

Perhaps the strongest link between conservation biology and Leopold's Land Ethic is the holistic theme of interconnectedness, communities and system integrity. Specific references to this theme include the extension of his discussion on the economic importance of species to include that of communities. He also warned that government could not manage for most ecological communities because they occurred on what we now call a landscape scale, often interspersed with private properties. Similarly, contemporary conservation biologists frequently insist that conservation problems do not recognize political boundaries and, therefore, solutions must address the issue of scale.

Leopold further emphasized the importance of communities and systems by presenting the notion of nutrient cycling and food webs as one of the most basic attributes of the land, and energy as the common currency of all systems. He suggests that evolution increases the diversity of the land and implies that a system's health depends on its ecological diversity. Conversely, Leopold notes that changes in systems occur naturally, but that the disruption of the nutrient cycle caused by mechanized humans is more profound than ordinary evolutionary changes. Like conservation biologists today, he warned that human-induced changes reduce diversity and simplify once complex systems.

Of Harriers, Mice and DDT

In the spring of 1957 the curiosity of Fran Hamerstrom directed her to a question: do harriers mate for life? In the following years this question developed into a series of additional questions, answers, and, most importantly, a framework to address a devastating conservation problem that had not yet reared its ugly head (Hamerstrom 1986).

Because of a paucity of data during the early years of wildlife management, most information was obtained through direct observation. So it was with Hamerstrom's harrier study where answers to the initial question of mate fidelity led to innovative techniques, such as color-marking, molt sequencing, and the determination of age and sex criteria for harriers (Hamerstrom 1986). The realization that harriers do not mate for life led directly to the broader question of what governs their mating system. The subsequent long-term investigation of this question focused on a wide range of factors affecting harrier populations. Information was collected on nest-site fidelity, mate fidelity, courtship behavior, productivity, nestling development, food items, home ranges, population indices, migration patterns, age structure, agriculture practices, and the relationship between harriers and their prey species. The interaction between harriers and their prey was further examined by measuring prey species composition, their annual abundances, reproductive output, sex ratios, age ratios and physical attributes. Collectively this broad body of knowledge led Fran Hamerstrom to two important discoveries each of which has implications in contemporary conservation biology.

First, Fran Hamerstrom detected a perturbation in the normal functioning system which she subsequently linked to the use of chemical contaminants, namely DDT. The ability to perceive an unhealthy disturbance in the system was directly related to the wide range of parameters measured in the study. For example, both harrier and microtine populations remained relatively high despite DDT applications, yet aberrant behavior and low reproductive success in harriers indicated the system had changed (Hamerstrom 1969). Collaboration with colleagues led to the discovery that DDT was indeed responsible for the observed environmental disturbance. Thus, a broad information base, as developed by Hamerstrom, is useful for detecting environmental perturbations and providing a sound scientific basis for making management decisions.

Secondly, she recognized that the abundance of voles regulates the number of breeding harriers and determines their mating systems (Hamerstrom et al. 1985). In order to provide an evolutionary context for this phenomenon, Hamerstrom et al. (1985) examined theoretical models and found their data supported the polygyny threshold model of Verner and Willson (1966). Edwards (1989) reported that placing wildlife research into a theoretical framework is necessary to understand complex biological interactions. Similarly, Hamerstrom's approach provides a solid foundation on which to make future management decisions and highlights the importance of a system and process oriented approach to conservation problems.

Grasslands and Pinnated Grouse

In the mid 1930s Frederick Hamerstrom Jr. joined a research program that was focused on developing a management plan to maintain huntable populations of Greater Prairie Chickens in Wisconsin. As the years progressed and prairie chicken habitat continued to disappear, Frederick Hamerstrom realized that the management plan might never provide a recipe for filling game bags with prairie chickens; however, he believed it could provide the key to saving the birds from extirpation in Wisconsin.

Like Leopold, the Hamerstroms believed that the importance of saving a species could not be measured in dollars. Indeed, Hamerstrom et al. (1957) explicitly stated that equal weight should be given to the value of hunting prairie chickens, observing them, and just knowing that they exist. Clearly this implies some intrinsic value associated with the preservation of the species. Even the value of hunting was not viewed by Frederick Hamerstrom as solely economic because he believed that much of what made people hunt had to do with the intangible "experience" it provided (F.N. Hamerstrom Jr. pers. comm.). Hamerstrom et al. (1957) further illustrated the influence of Leopold by reporting their belief that prairie chickens are valued by hunters and nonhunters alike as part of Wisconsin's heritage. The prairie chicken, now considered to be a threatened species in Wisconsin (Wisconsin Department of Natural Resources 1989), continues to persist in the state's last stronghold. The progressive approach used by Hamerstrom et al. (1957) to preserve this bird received international recognition and resulted in a comprehensive guide to prairie chicken management in Wisconsin.

The Hamerstroms' approach to saving the prairie chicken was to develop a management plan based on extensive research of a range of interactions between the birds and their environment, including information on seasonal habitat use, food preferences, mating systems, productivity, survival, ecological landscape, hunting, diseases and parasites, predators, and weather. Thus, the final plan was holistic in its approach and was based on sound scientific evidence, whereby factors responsible for population declines were identified and prioritized. Ultimately, nesting and brood cover were identified as the weak links in the system with winter food as a lesser consideration.

The most innovative part of the plan was Hamerstrom's long-term solution proposing landscape-scale management. Specifically, a system of grassland reserves, providing the limiting nesting and brood cover, would be dispersed throughout the management area to maximize the effective range of the prairie chicken (Hamerstrom et al. 1957). Hamerstrom considered factors such as the distribution and interspersion of reserves, their size, number, cost, as well as the effects of their edges. The Hamerstrom team eventually recommended dispersed parcels of grasslands rather than one large reserve because previous research indicated prairie chickens were able to satisfy some of their requirements from existing farmland. Therefore, interspersing small grasslands which provided nesting and cover for brood rearing among existing farmland increased the total area of suitable habitat. Presently, the important question of whether reserves should consist of a single large block of land or several smaller blocks (SLOSS) is still debated among biologists (Jarvinen 1982, Soule and Simberloff 1986).

ARE WE ON THE ROAD TO A LAND ETHIC?

The widespread recognition that both Frederick and Frances Hamerstrom received for their work testifies to the effectiveness of their approach. Why then is "conservation biology" only now gaining widespread acceptance? The process of self-examination by the wildlife profession provides several clues. Following the establishment of The Society for Conservation Biology and the publication of its journal, Conservation Biology, a series of authors debated the need for a new professional group and examined the role of conservation biology relative to the more traditional profession of wildlife management (Temple et al. 1988, Anonymous 1989, Bolen 1989, Edwards 1989, Gavin 1989, Hunter 1989, Teer 1988, Wagner 1989). Wagner (1989) reported that wildlife is managed to satisfy social values, and there is a clear perception that the wildlife profession has not kept up with the changing expectations of society. Empirical evidence suggests that the wildlife profession has continued to concentrate on economically important species despite society's increasing insistence on protecting a broader range of wildlife, including endangered and nongame species (Slack and Silvy 1990). This in turn led to a void between the expectations of society and the direction of the wildlife profession that is currently being filled by the Society for Conservation Biology.

Society's perception of conservation issues is changing as evidenced by increased media coverage, environmental literature, and political and legal attention focussed on the environment. Communities and some states now have mandatory recycling laws and energy conservation programs. Environmental issues now appear regularly on the front page of newspapers, and are featured prominently in nonscientific publications. The amount of environmental literature available to scientists and conservationists has also increased as the number of environmental journals grew fiftyfold from 1970 to 1980 (Western 1989). In 1987, 49 nations signed a landmark agreement proposing ways to forestall continuing losses of stratosphere ozone (Western 1989). More recently a proposal put forth by the United Nations calls for strict international guidelines to maintain clean air and water throughout the globe (Wall Street Journal, 31 January 1992).

In 1949 Aldo Leopold predicted that until society became more ecologically conscious and moved towards what he termed a land ethic, his approach to conservation problems would not be successful (Leopold 1949). In light of the trends outlined above, I suggest that society is indeed moving towards a land ethic. As a result, I feel that our acceptance of the approach endorsed by contemporary conservation biologists and their predecessors represents a corresponding lurch ahead.

ACKNOWLEDGMENTS

I thank R. Douglas Slack, Keith Bildstein and Robin Gawlik for stimulating discussions on this topic and for encouraging me to develop this essay. I also thank J. Baird Callicott for introducing me to The Land Ethic. Mike Brown, Felipe Chavez-Ramirez, Douglas Harpole, Thomas Lewis, J.S. Rowe, and Charles A. Tinn made helpful editorial comments.

LITERATURE CITED

ANONYMOUS. 1989. The future of wildlife resources cannot afford strange or unwilling bedfellows. *Wildl. Soc. Bull.* 17:343-344.

BOLEN, E.G. 1989. Conservation biology, wildlife management, and spaceship earth. *Wildl. Soc. Bull.* 17:351-354.

CALLICOTT, J.B. 1986. On the intrinsic value of nonhuman species. Pages 138-172 *in* B.G. Norton (ED.), The preservation of species. Princeton University Press, Princeton, NJ.

———. 1990. Whither conservation ethics? *Conservation Biology* 4:15-20.

EDWARDS, T.C., JR. 1989. The Wildlife Society and the Society for Conservation Biology: strange but unwilling bedfellows. *Wildl. Soc. Bull.* 17:340-343.

ERRINGTON, P.L. AND F.N. HAMERSTROM, JR. 1937. The evaluation of nesting losses and juvenile mortality of the ring-necked pheasant. *J. Wildl. Manage.* 1:3-20.

GAVIN, T.A. 1986. Conservation Biology and the potential loss of a participant allele. *Bulletin of the Ecological Society of America* 67:171-175.

———. 1989. What's wrong with the questions we ask in wildlife research? *Wildl. Soc. Bull.* 17:345-350.

HAMERSTROM, F. 1969. A harrier population study. Pages 367-383 *in* J.J. Hickey (ED.), Peregrine Falcon populations: their biology and decline. University of Wisconsin Press, Madison, WI.

———. 1986. Harrier: hawk of the marshes. Smithsonian Institution Press, Washington, DC.

———, F.N. HAMERSTROM AND C.J. BURKE. 1985. Effect of voles on mating systems in a central Wisconsin population of harriers. *Wilson Bull.* 97:332-346.

HAMERSTROM, F.N., JR., O.E. MATTSON AND F. HAMERSTROM. 1957. A guide to prairie chicken management. Technical Wildlife Bulletin 15, Wisconsin Conservation Department, Madison, WI.

HUNTER, M.L., JR. 1989. Aardvarks and Arcadia: two principles of wildlife research. *Wildl. Soc. Bull.* 17:350-351.

JARVINEN, O. 1982. Conservation of endangered plant populations: single large or several small reserves? *Oikos* 38:301-307.

KELLERT, S.R. 1986. Social and perceptual factors in the preservation of animal species. Pages 50-73 *in* B.G. Norton (ED.), The preservation of species. Princeton University Press, Princeton, NJ.

LEOPOLD, A. 1933. Game management. Charles Scribner's Sons, New York.

———. 1949. A sand county almanac: and sketches here and there. Oxford University Press Inc., New York.

MEINE, C. 1988. Aldo Leopold: his life and work. University of Wisconsin Press, Madison, WI.

MURPHY, D.D. 1990. Conservation biology and scientific method. *Conservation Biology* 4:203-204.

NORTON, B.G. 1988. What is a conservation biologist? *Conservation Biology* 2:237-238.

SLACK, R.D. AND N.J. SILVY. 1990. Have The Wildlife Society's publications kept pace with the profession? *Trans. North Am. Wildl. and Nat. Resour. Conf.* 55:164-173.

SOULÉ, M.E. 1985. What is conservation biology? *Bioscience* 35:727-734.

———. 1987. History of the Society for Conservation Biology: how and why we got here. *Conservation Biology* 1:4-5.

——— AND D. SIMBERLOFF. 1986. What do genetics and ecology tell us about the design of nature reserves? *Biological Conservation* 35:19-40.

TEER, J.G. 1988. Conservation biology. The science of scarcity and diversity. Book review. *J. Wildl. Manage* 52:570-572.

TEMPLE, S.A., P.F. BRUSSARD, E.G. BOLEN, H. SALWASSER, M.E. SOULE AND J.G. TEER. 1988. What's so new about conservation biology? *Trans. North Am. Wildl. and Nat. Resour. Conf.* 53:609-612.

VERNER, J. AND M.F. WILLSON. 1966. The influence of habitats on mating systems in North American passerine birds. *Ecology* 47:143-147.

WAGNER, F.H. 1989. American wildlife management at the crossroads. *Wildl. Soc. Bull.* 17:354-360.

WESTERN, D. 1989. Population, resources, and environment in the twenty-first century. Pages 11-25 *in* D. Western and M.C. Pearl (EDS.), Conservation for the twenty-first century. Oxford University Press, New York.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES. 1989. Endangered and threatened species list. Bureau of Endangered Resources, Madison, WI.

Received 18 March 1992; accepted 29 April 1992