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The Ethics of Ecological Field Experimentation

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Abstract: *Ecological field research has generated a wealth of valuable information, much of which informs conservation efforts. Such research raises ethical issues when we propose to modify or endanger the individual organism, population, species, or ecosystem we study. Yet the scientific literature contains little explicit consideration of the impact of ecological study itself on organisms or ecosystems. We propose that the lack of public ethical discourse among field scientists is due to (1) trepidation about initiating a controversy that could endanger future research efforts; (2) an assumption that the relative benefits of our research outweigh potential short-term costs to the study object (that is, increased knowledge of the study object may inform its conservation); (3) difficulties in perceiving the potential negative impact of our work; (4) tacit assumptions about certain experiments that are simply "wrong" to do. Ethical considerations have already arisen with the collection of organisms, the effects of scientific observation on survivorship and behavior, and experimental manipulations of whole ecosystems. The literature on environmental ethics and animal experimentation, two sources that bear tangentially on the issues of ecological ethics, may afford diverse and occasionally conflicting value systems on which to build an ethic of ecological experimentation. Although methods specifically devised to minimize the impact on study subjects have been published, we find few existing formal mechanisms of external regulation or self-regulation of research activities in the field. We suggest*

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La ética de la experimentación ecológica en el terreno

Resumen: *La investigación ecológica en el terreno ha generado un caudal de información valiosa, mucha de la cual considera esfuerzos conservacionistas. Dicha investigación pone de manifiesto valores éticos cuando nosotros proponemos modificar o poner en peligro el organismo individual, la población, las especies o los ecosistemas que estudiamos. Sin embargo, la literatura científica raramente considera en forma explícita los impactos de los estudios ecológicos en sí mismos, sobre organismos o en ecosistemas. Nosotros consideramos que la falta de una discusión ética pública entre científicos que trabajan en el terreno es debida a: (1) temor a iniciar una controversia que pueda poner en peligro esfuerzos de investigación futuros; (2) asumir que los beneficios relativos de nuestra investigación exceden los costos potenciales a corto plazo del objeto en estudio (es decir, un aumento en el conocimiento del objeto en estudio que pueda ayudar a su conservación); (3) dificultades en percibir el potencial impacto negativo de nuestro trabajo; (4) suposiciones tácitas acerca de ciertos experimentos que son simplemente "incorrectos" de llevar a cabo. Ya han surgido consideraciones éticas con respecto a la colección de organismos; los efectos de observaciones científicas sobre la supervivencia y comportamiento, y la manipulación experimental de ecosistemas en su totalidad. La literatura sobre ética ambiental y experimentación animal, dos fuentes que tratan tangencialmente cuestiones de ética ecológica, pueden proporcionar diversos sistemas de valores, a veces conflictivos, sobre los cuales construir una ética en experimentación ecológica. Si bien, han sido publicados métodos específicamente diseñados para minimizar el impacto sobre*

that ethical considerations, conservation and restoration measures that are compatible with sound scientific protocols, may be profitably incorporated into the design of field experiments. We encourage a dialogue between scientists and philosophers on this issue.

los objetos a estudiar, nosotros encontramos que existen pocos mecanismos formales de regulación externa o autoregulación de la investigación sobre el terreno. Nosotros sugerimos que sería beneficioso incorporar dentro del diseño de experimentos de campo consideraciones éticas, y medidas de conservación y restauración que sean compatibles con protocolos científicos. Nosotros incitamos a un diálogo entre científicos y filósofos en este tema.

Introduction

How often do we, the scientific community, consider the consequences of our activities in the field? Research undertaken by field biologists on organisms and ecosystems has heightened human understanding of the living world and our impact upon it; it has guided the development of paradigms of biological conservation; and it increasingly informs public policy on land use and the protection of species. The merit of this type of work is not in question here. But this research often exerts its own impact on the system under scrutiny; even the simple act of observing changes the observed. Given burgeoning public concern over ethical issues in science, including those bearing on the value of medical research and environmental quality, it seems timely for us as field biologists to discuss and perhaps challenge some of our ethical assumptions regarding experimentation. Approaching these questions from our scientific perspective, we must cautiously and inexpertly borrow from the language of philosophers. We seek to engage ethicists and biologists in a dialogue on the ethical and biological ramifications of field research.

Ecology, like most sciences, entails experimental manipulation of organisms or their physical environment, active observation, and deliberate or inadvertent disturbance of organisms in nature. Destructive sampling, labeling of microsites, removal or transplantation of vegetation, and the collection and sacrifice of specimens are common methods in field research. Occasionally these manipulations involve whole ecosystems, perturb fragile communities, or involve rare or endangered species. Herein lies an ethical dilemma: the same work that would both derive from and support an ethic of conservation also may cause damage to the very biotic systems it seeks to understand. It is time to recognize and question the assumptions that we make in choosing our field sites, study organisms, and experimental designs. In this paper, we ask the following questions:

- Do we as researchers consciously invoke a coherent system of ethics in designing our ecological experiments in the field?
- Are these ethical decisions or constructs anywhere explicitly stated? If not, why not?
- Does the community of field researchers need to discuss and develop a body of experimental ethics, especially before others question or regulate our research activity? What existing sources may we draw from in developing an ethical foundation for our work?

Our inquiry will inevitably generate more questions than it can hope to answer. We raise this issue in the hope that it will stimulate discussion among philosophers and field biologists alike.

Notes from the Ethical Literature

Published discourse on ethics in ecological experimentation is very limited. Instead, certain background material is available from two sources that are only tangential to the actual issue: animal rights literature and environmental ethics literature. These two sources derive from differing tenets (Callicott 1980) and may at times contradict or bolster each other's aims. For example, conflicts have occurred when "rights" groups have prevented "environmentalists" from eradicating nonnative intruders that would threaten indigenous organisms (Knox 1991). Likewise, supporters of animal rights (see Regan 1983) may not necessarily support species' rights (see Rolston 1985). However, the same ethical systems that advocate a respect for the welfare of animals can be used to argue for the wise stewardship of natural resources.

Numerous economic, aesthetic, and moral arguments exist to justify why the care and concern for organisms is necessary. Ethicists have argued for and against the rights of individual animals used in scientific research (for a range of opinions, see Singer 1975; Regan 1983; Rollin 1985; Vaughan 1988) and have also evaluated our moral responsibilities to species (Rolston 1985; Callicott 1986; Norton 1986 and references therein; Sober 1986). We do not intend to recapitulate these arguments in detail here, nor do we present an exhaustive review of the wide range of ethical literature. Rather, we sketch some background for the interested reader, and we ask if some of these broad principles may be adapted toward consideration of natural systems.

Environmental Ethics

The past four decades have witnessed the emergence of a variously articulated environmental ethic that espouses a general respect for the earth and urges the wise use of its natural resources (see Leopold 1949; Commoner 1974; Erlich & Erlich 1981). This major social and political movement has alerted the scientific community to the fact that the objects of our research are a limited and shrinking resource, and that care must be taken in the handling of that resource, be it an organism or an ecosystem. Many environmentalists have found that defending groups of organisms, or the physical habitat they require, entails petitioning sets of values based on enlightened self-interest (utilitarianism) or empathy. Appeals by conservation organizations frequently draw on public concern for charismatic megafauna, from elephants and pandas (Sunquist 1992) to spotted owls. They solicit compassion for organisms (often neotenic mammalian species) with whom humans may identify or find uses. It is intuitively easier to focus ethical concern on the plight of a single, demonstrably sentient organism than it is to engender a sense of moral responsibility for a whole ecosystem (Rolston 1981; Kellert 1986). Respect for "the land" is more difficult to invoke, although numerous writers since Thoreau have evoked a land ethic by conveying a strong sense of place in their writings. It is arguable whether a unit so nebulous as an ecosystem deserves moral consideration at all, because ecosystems show neither overt suffering nor a semblance of interests or free will (Cahen 1988).

Environmental philosophers have attempted to discern what value systems inform humans' feelings toward nature—that is, nonhuman animals, communities, and ecosystems (sometimes spuriously) distinguished from human-based systems. Various analysts (such as Mathiessen 1959; Clement 1979; Rolston 1981; Kellert 1986, 1991) have articulated many of the attitudes that humans exhibit toward nature, attitudes that ultimately inform ethical codes of conduct. These analyses reveal that feelings about specific species vary among cultures, and are generally biased against life forms such as plants and invertebrates that do not exhibit overt purposeful action or sentience. These biases may operate in the realm of scientific inquiry as well.

For our purposes, four encompassing attitudes toward nature (summarized by Kellert 1991) may be most relevant. *Scientistic* value systems view nature as a focus of intellectual curiosity, as potential sources of answers to theoretical or practical problems. These values likely spur much current ecological research. Scientistic postures are commonly seen as value-free, arising from the "objective" pursuit of the scientific method. Anthropomorphic compassion for a study organism may be seen as interfering with the objectivity for which scientific studies strive.

Ecologistic value systems are oriented toward the appreciation and protection of whole ecological systems, informed by a knowledge of how physical and biotic components of ecosystems work together. Field biologists have accrued much information about ecosystem functioning, data that have shaped environmental policy, conservation efforts, and restoration strategies (Jordan et al. 1990).

Moralistic attitudes assume that absolute good and wrong govern the treatment of animals and natural systems, and that humans have definite duties to minimize harm. The language of contemporary American conservationists is also commonly couched in terms of the perceived rights of species, and many conservationists have argued that humans have no right per se to cause the extinction of other species (see Muir 1901; Leopold 1949; Ehrlich & Ehrlich 1981; Callicott 1986). Moralistic philosophies are opposed to exploitation or harm, especially when it can be shown to cause pain. Here, the opinions of animal rights moralists and environmental ethicists may coincide, though their directives may diverge.

Utilitarian modes of reasoning arise from the premise that nature provides material benefits that increase the common good of humans, and that it is possible through some common currency to weigh human welfare justly against ecological welfare. Economists are now developing means by which to assign tangible monetary value to ecological systems (see Daly & Cobb 1989). Nature is perceived as valuable if it fulfills a pragmatic human need. Utilitarianism has provided the foundation for cost-benefit and environmental impact analyses used to project the long-term effects of projects with detrimental ramifications for the environment (Rolston 1981, 1985). Utilitarian approaches might also justify short-term harm to a certain community if a greater ecological good (measurable in economic terms) were expected of the action. Thus we gamble with encroachment on an endangered species or territory in hopes that our expanded comprehension of the system will ultimately facilitate its survival, and possibly our own.

The Ethics of Ecological Studies on Animals

Concern for the welfare of animals used in research has developed with the growth of modern laboratory science. In recent years the emphasis has shifted from animal welfare to animal rights (a moralistic stance), concerned with the intrinsic right of an animal to be free from pain and constraint (Regan 1983). This viewpoint is often in direct conflict with the perceived rights of biologists, or the rights of human beneficiaries of medical cures or other products of animal experimentation (Dodds & Orlans 1982; Rollin 1985). Abundant cogent

discussions of both sides of this volatile issue are available (see Fox & Mickley 1987; Vaughan 1988). Rejoinders from the scientific community vary from justifications of animal use (Miller 1985) to the development of explicitly stated alternatives (Huntingford 1984; Gallup & Suarez 1985) and institutionally imposed guidelines (Association for the Study of Animal Behavior 1981; Moss 1992).

Animal rights activists (*sensu lato*) contend that sentient species suffer from pain regardless of the complexity of their nervous systems, and therefore should be treated as a human would (Singer 1975). Many writers condemn speciesism (see Regan & Singer 1976), the premise that more "evolutionarily advanced" organisms are more worthy of care and consideration than are the lower orders. Medical researchers, particularly those who work with primates or other vertebrates to simulate human physiology, have borne the brunt of public opprobrium associated with the deliberate infliction of pain or death on study animals. Biologists manipulating invertebrates, plants, or whole ecosystems have not, for the most part, had to address direct objections from the public.

The tacit assumption of a hierarchy of value in organisms is solidly incorporated into our culture. Our very existence as a species has entailed the destruction of habitat and other organisms. Our ethical assumptions regarding the environment and our moral duties to organisms reflect this value hierarchy and dictate both economic agendas and research activity. In field-based research, as with environmental ethics, questions of our responsibilities to our objects of study become more diffuse as we try to address higher levels of biological organization such as the population, community, or ecosystem. When ecological methods pose inherent moral dilemmas, we must clearly articulate the dilemma in both moral and biologically meaningful terms. At what biological level (individual, local population, species, and so forth) is the object of our study morally considerable? Is there a moral imperative that suggests that we ought to avoid causing disturbance or harm in the field whenever possible? If human presence disturbs an organism, a population, a species, or a community, are we obliged to stay away (Wilkes 1977)? Is individual death "better" than extinction of a species (Norton 1986), especially when definitions of "the species" are still biologically problematic (O'Brien & Mayr 1991)? Field biologists do not currently possess adequate mechanisms to evaluate how often extinction or environmental damage may result from our actions. It is generally left to the judgement of the individual biologist to decide when disturbance due to field practices is justifiable. The paucity of discussion of these issues in the literature makes it difficult to assess how individual scientists make these decisions, or how the sum of these decisions affects the organisms that we study and the science that we do.

Case Studies from the Ecological Literature

It is generally accepted that in situ experiments are necessary to gain ecologically realistic information on the system or organism of study. The scale of experimental treatments can in part determine the long-term effects of the research methods on study organisms and their environment. Examples of traditional field techniques with long-term ramifications include the introduction of non-native predators or other invasive species to islands, the introduction of foreign material to lakes and streams, and the establishment of plots in areas where vegetation recovery time is slow. Collections of sufficient numbers of specimens to make reliable taxonomic distinctions, to satisfy statistical sampling needs, to enable gut content analysis, or to estimate population sizes also may deplete the study population locally. Intensive observations of a population; the use of blinds, radio telemetry, and assorted marking techniques; or manipulations such as introductions, exclosures, selective culling, and ecotoxicity studies can induce changes in animal behavior, survivorship, and community structure. We now examine ethical issues associated with some of these methods. The scenarios we focus on are not meant to target any particular line of research; rather, they are offered as general examples of common field techniques for which researchers themselves have recognized ethical ramifications.

Observations of Animals in the Field

Ecologists have long recognized that the simple act of observation may affect the behavior of study organisms. Goodall (1986) noted the responses of chimpanzees to human activity and found that their cognizance of human presence was high. She thus cautioned that the factor of human disturbance must be taken into account when "making generalizations that apply to the species as a whole." Ornithologists have acknowledged that, among birds, human intrusion can influence social interactions, the reproductive performance of adults, and the survivorship of chicks (Ellison & Cleary 1978; Gottfried & Thompson 1978; Nisbet 1978; Duffy 1979; Anderson & Keith 1980; Cooke 1980; Fetterolf 1983; Westmoreland & Best 1985; Belanger & Bedard 1989). One recent study demonstrated that gulls recognized individual researchers and learned to flee, frustrating the scientist's attempts to visit the colony (Spear 1988). Methods of marking individuals with colored bird bands, radio collars, subcutaneous implants, paints, or dyes may inflict pain, increase the risk of predation, or

affect mate choice and reproductive success. While these methods offer effective means for field identification of animals, they may exert an influence on the organisms' behavior that must be accounted for in research results and in our interpretations of "normal" baseline behavior.

It is possible that any organism that exhibits a negative response to human intrusion will suffer reduced fitness from repeated visits by scientists. Researchers undoubtedly take precautions to prevent or lessen detrimental effects on organisms, but at best such measures are only vaguely implied in the published experimental design. It would be interesting to know how many experiments have been constrained or modified out of concern for the organism itself.

Collection of Organisms in the Field

Other ethical issues arise when we propose to collect study organisms. The question of when collection is warranted is contentious, especially in shrinking tropical habitats; controversy exists over collection of rare specimens for captive propagation or for taxonomic identification and vouchering. For example, an ornithologist recently eschewed the normally accepted practice of killing and preserving the only known specimen of the Bulo Burti boubou of Somalia, in favor of taking a year's worth of blood samples and behavioral data before releasing the bird—a practice that caused considerable consternation among taxonomists (Yoon 1992). Sometimes we may learn of a particular species only when it appears in our mist nets, pitfall traps, or fishing seines. There is an urgent need for data on global species diversity: species counts and the presence of rare species often inform conservation policies (Erwin 1983*a*; Greene 1988; Gaston 1991). Yet where a species is locally rare or confined only to a tiny habitat such as a single tree, is it tenable to risk reducing the population through collecting (Larochelle & Bousquet 1978; Erwin 1983*b*)? Diamond (1987) states the problem eloquently in an essay addressing controversial bird collecting: "The affair provokes the question of whether scientific collecting of birds [or other organisms] is at all justifiable today, when wholesale destruction of habitats for timber and agriculture is already reducing populations." Diamond also points out ironically that governments strictly regulate collecting by scientists, yet condone or encourage the devastation of land that would support these species. Because collecting practices often have been singled out by regulatory agencies, it has become incumbent upon ecologists to develop methods that supply necessary information quickly in a manner compatible with larger conservation strategies, but these methods are hotly debated.

Ecosystem-Level Studies

Finally, ecologists frequently initiate large-scale experiments designed to determine the effects of factors such as toxins, new species, and local extinctions on an existing ecosystem (see Likens 1985 for a review). Such manipulations have greatly increased our knowledge of ecosystem structure and function and provide strong evidence (see Platt 1964) to support or refute ecological theories. The establishment of long-term ecological research sites by the U.S. National Science Foundation and other comprehensive field projects elsewhere have enabled ecologists to institute multi-year experiments encompassing whole watersheds (Likens 1985) to study such phenomena as deforestation, global climate change, and atmospheric pollutant deposition (see Herrick 1988).

Such experiments contain their own limitations, principally "because of the difficulty of replication and the great temporal variability of ecosystems" (Carpenter 1989). Recent discussion has focused on the level of replication and treatment strength necessary to ensure statistically reliable results. Increasingly efficient analytical techniques are being developed (Likens et al. 1970; Schindler 1977; Schindler et al. 1985; Carpenter 1988) to streamline experimental design while avoiding pseudoreplication (see Hurlbert 1984).

Yet for all the considerable technical accomplishments of ecosystem-level studies, discourse in the scientific literature of the ethics of altering whole ecosystems such as lakes, streams, and forests appears to be limited to the release of genetically-engineered organisms (Tiedje et al. 1989). In a recent review of the issues surrounding such releases, Tiedje et al. (1989) acknowledge that "economic, social, and ethical concerns also must be weighed along with strictly ecological and evolutionary considerations, but these other issues are beyond the scope of this report." We do not take issue with the safety of this practice; we merely wonder if ethical considerations will always be relegated to another venue. Do philosophers and legislators hold a monopoly on ethical vocabulary?

Assumptions and the Lack of Public Discourse

Returning to our original three questions, we ask, do we and should we consciously invoke a coherent system of ethics in designing our field experiments? We have seen that elements of both environmental ethics and animal-centered ethics are germane to ecological research, but these considerations alone may not be adequate to encompass non-animals, whole populations, communities, or ecosystems. We may need to devise new ethical systems based on scientific, naturalistic, or utilitarian grounds in order to address these areas of scientific en-

deavor. We asked whether these ethical decisions or constructs are anywhere explicitly stated. A review of the literature reveals that if field biologists are taking ethical issues into account, they are rarely saying so. Why, in a time when science comes under public fire from activists and government alike, is there little more than cursory mention of ecological ethics? We contend that four considerations have discouraged public discussion of this issue.

First, the community of ecologists may be understandably gun-shy, having witnessed the sometimes violent attacks upon their colleagues by "animal liberationists." Contentious and emotional debaté, the prospect of litigation, and the possibility of regulation or sabotage may stifle open discussion among ecologists themselves. Likewise, ecologists conducting research on sensitive species or sites may run the risk of being denied access by wary land owners and managers.

Second, many ecologists may be motivated by the tacit utilitarian assumption that the potential benefits of knowledge acquired will far outweigh the short-term costs of research. This argument is frequently used to defend the use of animals in medical research. It can also be applied to ecology, especially where research may ultimately lead to the conservation or protection of the entire species or the habitat in question. We cannot conserve until we comprehend; thus we identify the expanded knowledge of our system as a good (Short 1986).

Third, it may be more difficult in a field situation to perceive—much less quantify—the negative effects of research activity. We may not directly detect the hardship that our treatments levy upon organisms or sites, and we may be hard-pressed to interpret increased mortality as a direct outcome of our actions, especially because harm was an unintended effect. If we do not actively look for these effects, we may not discern the long-term influences of our experiments on our sites or our subjects.

Fourth, we may avoid devising some research protocols on the assumption that "certain experiments are simply wrong to do," but we rarely state why explicitly. For example, Diamond (1983) offers a potential alternative to invasive field experiments in the form of the "natural experiment." He asserts that in many situations nature has done the manipulation for us—a hurricane has toppled a forest, a fire has ravaged Yellowstone—and we may garner useful information from these uncontrolled but scientifically serendipitous events. In citing the problems inherent in artificial field treatments, Diamond points out that "for many species in many places, the merits and drawbacks of field experiments become academic: local removal or introduction of species would be technically impossible, morally reprehensible and politically forbidden." Natural experiments afford us the opportunity to make weak inferences (see Platt 1964) about the effects of particular phenomena on natural systems, "to examine systems that cannot, may not or should not be created experimentally" (Diamond 1983).

Others have taken up the issue of Diamond's proposed approach (Hairston 1989), and we do not intend to debate the efficacy of the method. Rather, we call attention to Diamond's ethically weighted wording. He implies unmistakably that there are ecological experiments that should not be undertaken for ethical reasons. Yet, significantly, he does not elaborate on why. His language is clearly informed by ethical assumptions, and he is one of the few ecologists expressing these considerations in the context of a published scientific commentary. Yet we are left to guess at the qualities that would make any field experiment morally "unjustifiable."

Huntingford (1984) represents an exception in the literature. She both states the dilemmas inherent in a particular form of behavioral experimentation and attempts to deal with them in designing a humane protocol. She reduces the potential suffering of her study organisms by (1) ensuring that "trivial" experiments are avoided, (2) encouraging collaborative research to streamline efforts, (3) collecting data on both natural and controlled encounters, (4) substituting models for live animals whenever possible, (5) minimizing sample sizes, and (6) keeping encounters/runs as brief as possible. Some of her solutions may be applicable only to the science of behavioral ecology, while others may be more broadly implemented. Regardless of the efficacy of her solutions, her approach represents one of the few efforts (outside of ornithology; see Still 1982) to identify, address, and resolve ethical issues a priori, and it has been adopted by others (see Hourigan 1986; Magurran & Girling 1986; Timberlake & Melcer 1988; Perrigo et al. 1989).

Questions of Regulation and Cooperation

Does an ethic apply to ecological research, one that might inform scientific research policy, and is it necessary or possible for the community of field researchers to devise general ethical guidelines for scientific activity? The same lessons that gave rise to an environmental ethic inform us that "nature"—the study organism, the pristine field site—is a limited and shrinking resource. Much ecological research is performed in areas relatively isolated from human activity, areas that are becoming increasingly rare. Unless deliberate steps are taken to minimize interference and impacts, scientific activity can exert severe pressures on a system. Many ecologists are aware of the duties we assume when we undertake a study in nature, and have a vested interest in controlling the amount of irreversible change inflicted

upon our study sites. Data are simpler to interpret if treatments are fastidiously applied and maintained, and it is more feasible to return to sites that have been only minimally damaged or fully restored.

As ecologists ourselves, we begin from the clear premise that ecological research is both needed and valuable, and that some manipulation and observation is required in order to answer questions in a scientifically meaningful way. We believe that it is healthy for a discipline to reflect upon its own assumptions and to acknowledge relevant ethical problems where they arise. Such inquiry is especially critical today, when scientists are increasingly called upon both to justify their research economically and ethically and to advise policy makers on environmental issues.

External Regulations

Some guidelines governing field experiments exist (Association for the Study of Animal Behavior 1981; Phillips & Szecher 1989; Moss 1992) or are being developed (Linnartz et al. 1990), but no comprehensive standard exists for protecting the integrity of natural systems under the scrutiny of research. To our knowledge, ecologists are subject to regulatory review by national funding agencies only if they propose to study vertebrates or rare or endangered species in the field or laboratory. Research occurring in the national park system is likewise subject to regulatory review (G. Streveler, personal communication). Park policy occasionally comes under public scrutiny and criticism, for example when the practices of brightly marking plots or animals may diminish the apparent pristineness of wild areas (S. Kellert, personal communication). Local agencies, such as state fish and wildlife offices, require special permission for projects concerning locally rare species, and many governments prohibit or strictly curtail collecting. Restoration following research rarely, if ever, comes under the purview of regulatory agencies. In the end, the emphasis of these review policies is on potential harm to the study organisms; the majority of field studies are not evaluated with regard to the integrated natural systems in which they occur.

Increased legislation or institutional regulation may not be the most appropriate response, in any case. If the need arises, establishing standards for self-governance under the aegis of the scientific community is a viable possibility. For example, Short (1986) suggests that disciplines and countries using primates in lab experimentation should establish a Code of Practice, Federal Inspectorates, and local Ethical Committees to oversee the ethical treatment of study subjects.

Can we assemble analogous institutions to oversee ecological field research? Regulations may involve ranking certain ecosystems on the basis of their rarity, size, diversity, pristineness, resident species, aesthetic and educational values, in addition to their importance to science (see Federal Register 1980; Spicer 1987; Jenkins 1988). Consistent environmental ranking schemes have been notoriously hard to develop for the purposes of protection, and devising new means of identifying appropriate research sites could be problematic.

Perhaps because few studies have involved large tracts of "sensitive" or "fragile" areas (but see Farnworth & Golley 1974; Platt et al. 1990), field scientists have not perceived a need for debate. The United States, for example, contains millions of hectares of comparatively undisturbed habitat, and experimental sites occupy only a fraction of that area (Osburn 1980). Even where sites and organisms already face disturbance or destruction, the objective may be to make the best of an already grave situation, such as the Minimum Critical Areas project in the Brazilian rainforest (Lovejoy et al. 1983).

Thus, numerous questions remain for discussion. Is it necessary to regulate ecological research to ensure the proper treatment of ecological systems, or would regulation stifle creativity? Even in the absence of formal regulation, is it advisable for ecologists to develop and articulate their own ethical standards? Should nature, as a limited resource, be rationed for research that is deemed critical? Does peer review adequately address these concerns?

Conclusions: Regulating Ourselves

Ecological science is poised on the horns of a dilemma created by the unique demands that society places upon it. Sagoff (1985) describes the responsibilities that society attributes to ecology as follows: "Ecologists may apply their science either to manage ecosystems to increase the long-run benefits nature offers man or to protect ecosystems from anthropogenic insults and injuries." These two goals may come into conflict, and the practice of field research may occasionally violate both of the objectives, at least in the short term. While individual ecologists may object to society's sometimes burdensome, stereotypic, and simplistic delineation of our roles, we are nonetheless answerable to an ethic generated by that society. And we are a "discipline with a time limit" (Diamond & May 1985). Programs such as the Sustainable Biosphere Initiative being developed by the Ecological Society of America (Lubchenco et al. 1991) illustrate that ecologists are beginning to recognize responsibilities to pursue integrated, basic, and applied research protocols that will ultimately promote the conservation of our study sites and species. Given the urgent and unprecedented threats facing the biosphere, it is timely—even imperative—to develop a consistent ethical foundation on which to base our research.

It is clear that the ecological community is aware of many of the ethical issues that arise in our work. Most

discussions of these issues take place as informal conversations among colleagues, and rarely in more public fora. We are advocating more open venues for biologists to air their ethical views and the incorporation of more explicit discussion of "ethical methods" (whatever these may be) into research publications. Can field biologists employ the language of philosophers to clarify our choices of research protocols? There are consequences for biological research. A diversity of opinion among field scientists and philosophers may narrow interdisciplinary rifts and help us begin to resolve some of these issues; such discussion can only serve to educate us all.

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