

Ecological Ethics: Building a New Tool Kit for Ecologists and Biodiversity Managers

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Abstract: *Ecological research and biodiversity management often raise ethical questions in areas that include responsibilities and duties to the scientific community, public welfare, research animals, species, and ecosystems. Answering these questions is challenging because ecologists and biodiversity managers do not have the equivalent of bioethics, an established field with a support network focused mainly on biomedicine, to guide them in making decisions. Environmental ethics provides some insight into environmental values and the duties these may impose on humans. But for the most part those in the field have not considered many of the common responsibilities and obligations that ecologists and managers have to the scientific profession or to public welfare. There is a need to bring ethicists, scientists, and biodiversity managers together in a collaborative effort to study and inform the methods of ethical analysis and problem solving in ecological research and biodiversity management. We present a series of cases that illustrate the kinds of ethical questions faced by researchers and biodiversity managers in practice. We argue for the creation of an extensive case database and a pluralistic and integrated ethical framework, one that draws from the theoretical (normative), research, animal, and environmental ethics traditions. These tools form the foundations of a new area of inquiry and practical ethical problem solving, that we call "ecological ethics."*

Ética Ecológica: Construcción de un Juego de Herramientas Nuevo para Ecologistas y Gestores de Biodiversidad

Resumen: *La investigación ecológica y la gestión de la biodiversidad a menudo generan cuestionamientos éticos que incluyen responsabilidades y obligaciones para la comunidad científica, el bienestar público, los animales, las especies y los ecosistemas utilizados en investigación. La respuesta a estos cuestionamientos es un reto porque ni los ecólogos ni los gestores de biodiversidad tienen el equivalente de la bioética, un campo establecido con un soporte basado principalmente en la biomedicina, para guiarlos en su toma de decisiones. La ética ambiental proporciona algo de entendimiento de los valores ambientales y las obligaciones que pueden imponer a los humanos. Pero la mayoría de las personas no han considerado muchas de las responsabilidades y obligaciones comunes que tienen los ecólogos y gestores con la profesión científica o el bienestar público. Existe la necesidad de reunir a estudiosos de la ética, científicos y gestores de biodiversidad para, en un esfuerzo cooperativo, estudiar e informar los métodos de análisis y resolución de problemas éticos en la investigación ecológica y gestión de biodiversidad. Presentamos una serie de casos que ilustran el tipo de cuestionamientos éticos que los investigadores y gestores de biodiversidad enfrentan en la práctica. Discutimos la creación de una base de datos extensa y de un marco ético integral, que se base en los preceptos de la ética teórica (normativa), de investigación, animal y ambiental. Estas herramientas constituyen los cimientos de una nueva era de investigación y resolución de problemas éticos, que llamamos "ética ecológica."*

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Introduction

When they confront difficult ethical questions in their work, biomedical scientists and clinicians can turn to bioethics, a recognized field within applied philosophy with a rich literature, for scholarly insight and practical guidance. Bioethics has a strong institutional presence in hospitals and research centers; scientists and clinicians often can and sometimes must consult directly with ethics committees or qualified bioethical personnel in their home institutions. Bioethics is embedded within these research and clinical communities, providing a recognized forum for the discussion of ethical issues, an established scholarly area of research yielding new research findings, and a support network to assist researchers and clinicians in making practical ethical decisions.

There is, however, no analogous subfield of applied or practical ethics devoted expressly to investigating the special kind of ethical issues raised within ecological research and biodiversity management contexts. Environmental ethics comes closest to filling this need, but it has not developed any special focus on the design and conduct of ecological field and laboratory experiments or (with a few notable exceptions) paid sufficient attention to the ethical dilemmas that often plague decision making in biodiversity management (including natural areas, botanical gardens, zoos, and aquaria). There is a need for a novel approach within practical ethics that cannot be met by simply stretching the current disciplinary boundaries of bioethics or environmental ethics as some have argued (e.g., Ehrlich 2003).

Experimental ecologists and biodiversity managers need a network and an ethical support system analogous to the one linking bioethics with biomedical scientists and clinicians. In recent years there have been increasing pleas for scientists to play a more active role in environmental policy discussions and to be more responsive to citizens' interests in maintaining biologically diverse, healthy, and productive ecosystems (e.g., Lélé & Norgaard 1996; Lubchenco 1998; Wilson 2002). These arguments are not entirely new, but their increasing frequency and moral seriousness suggest that more than ever ecologists are being asked to provide citizens and policy makers with the knowledge and tools for conserving biological resources and planning for sustainable development. In attempting to meet their end of this "social contract," ecological researchers confront an expanding set of ethical challenges that are in part a function of their field's growing technical acumen and increasing, though by no means complete or infallible, predictive power. Indeed, designing and conducting ecological research and managing biological resources often raise ethical considerations relating not only to an ecologist's responsibilities to public welfare and the scientific community but also to his or her obligations to wild animals, species, and ecosystems.

Consider the following case (recently documented in *Science*). Six of the Channel Islands of California have endemic subspecies of the island fox (*Urocyon littoralis*), an endangered species, and feral pig (*Sus scrofa*) populations. Golden Eagles (*Aquila chrysaetos*), a federally protected species, recently colonized the islands and drove two fox subspecies to extinction and reduced a third species to < 100 animals (Courchamp et al. 2003). Eradicating pigs was planned for early 2004, but population models demonstrate that eagles will then feed more heavily on foxes and trigger their extinction. Translocation alone will not eradicate the eagles, so lethal removal is suggested as the way to save the fox. What values should guide the decision regarding the appropriate conservation target in this case? Should both species be saved at any cost? If not, why does one species deserve to be saved and not the other? Is there a principled way to resolve these questions?

We believe that ecological scientists, biodiversity managers, and practical ethicists have for the most part devoted little systematic effort to exploring these sorts of issues. Exceptions include a handful of researchers who have investigated the social roles and ethical responsibilities of conservation biologists, including their obligations to ecological systems (e.g., Shrader-Frechette & McCoy 1999; Potvin et al. 2001; Lodge & Shrader-Frechette 2003) and related discussions regarding the ethical context of ecological restoration (e.g., Light & Higgs 1996; Gobster & Hull 2000). Still others have considered some of the animal and environmental ethical questions raised by zoo conservation strategies and techniques (Norton et al. 1995), the conceptual and moral considerations surrounding in situ and ex situ conservation of plants (Rolston 2004), and the ethical obligations of scientists who study wildlife in the field (Bekoff & Jamieson 1996; Monamy & Gott 2001; Swart 2004).

Especially relevant for our purposes is the small number of papers within this literature that have stretched the scientific research ethics discussion to include recognizing the field and laboratory researcher's responsibilities to ecological systems. These include general duties in biological field research (Farnsworth & Rosovsky 1993), specific obligations to avoid harming protected areas in field research (Marsh & Eros 1999; Marsh & Kenchington 2004), and duties to the environment as part of the decision-making process within conservation biology (Shrader-Frechette & McCoy 1999). Finally, there is a significant body of work on the general relationship between ecological science, ethics, and conservation policy, including efforts to reform the field of environmental ethics into a more policy-oriented enterprise (e.g., Norton 1987, 2003; Light & Katz 1996; Frodeman 2004).

Although we can point to these and related attempts to focus more intently on the moral dimensions of ecological research and management, this work has not been

coordinated in such a manner that it forms a self-conscious intellectual community with an explicit research agenda. Consequently, there needs to be a more concerted attempt to organize and integrate the discussion across the sciences, humanities, and conservation professions. Writing in these pages some years ago, Farnsworth and Rosovsky (1993) advocated a multidisciplinary dialog among field biologists and philosophers that would address some of the ethical questions we have identified. Our reading and experience, however, suggest this dialog has still not happened (Marsh & Kenchington 2004).

There are some cases of bringing ethical considerations into ecological and management practice but more development is needed. The Ecological Society of America (ESA), for example, has a code of ethics, but the code's principles are general statements covering issues mostly within the boundaries of conventional professional and research ethics (e.g., avoiding scientific misconduct, conflicts of interest). Only one principle in the ESA code speaks directly to concerns about avoiding or minimizing "adverse environmental effects" by suggesting that ecologists comply with "legal requirements for protection of researchers, human subjects, or research organisms and systems" (www.esa.org/certification/codeofEthics.php). "Adverse environmental effects" are not defined clearly and why these effects are undesirable in an ethical sense is not specified. Appealing to legal requirements in such a code is also not a substitute for ethical reflection, especially because legal codes may lag the practical ethical dilemmas encountered in ecological research (Angulo & Cooke 2002).

In addition to the limits of the ESA code of ethics, there is little attention to the ethical implications of ecological research in the society's vision statements, such as the *Sustainable Biosphere Initiative* (Lubchenco et al. 1991) and the recently released report titled "Ecology for a Crowded Planet" (see Palmer et al. 2004). Although these publications address the scientific and social missions of ecologists as contributors to a sustainable environment in an age of ecological overburdening, neither draws attention to the ethical issues confronting ecologists and managers in their work. Recent formative attempts within ESA to develop this sort of discussion (panel on ethics in ecology convened at 2004 annual meeting) suggest an increasing interest in these issues.

In philosophical ethics, the situation is not much more evolved than it is within ecological science. Although the field of environmental ethics has and continues to make important contributions to our understanding of a host of conceptual issues regarding the nature of environmental values and the duties these impose, for the most part it has not been as successful in addressing in a comprehensive and sustained manner the more concrete ethical concerns encountered in practice (Minteer 1998). The foundational, theory-building mission in environmental

ethics has great value, and we do not want to be read as demeaning its value. But we need to revise and find ways to use this and other ethical theory more effectively to inform decision making in practical contexts such as designing and conducting ecological field and laboratory experiments and making biodiversity management decisions in problematic situations.

Scientists, managers, and ethicists can all learn by studying jointly the ethical issues confronting practicing ecologists and biodiversity managers. Doing so will help ecologists respond more effectively to the ethical challenges encountered in their research and help them lead discussions of proper research design and management rather than waiting for more slow-moving, ambiguous, and often unwieldy legal guidelines and prohibitions to point the way (Angulo & Cooke 2002). In short, we need a new approach in practical ethics, one we term "ecological ethics."

We offer a few exemplary cases in ecological research and biodiversity management and discuss some of the specific ethical considerations they raise for scientists and managers. We also outline the relevant literatures in theoretical and applied ethics that speak to the duties and responsibilities of these same communities. We end with a call for the collaborative development of a pluralistic ethical framework for making decisions, one that will be a heuristic and analytical instrument informed by multiple domains within theoretical and applied ethics.

Ethical Dilemmas in Ecology and Conservation Biology

We focus on four general issues or situations in ecological research and biodiversity management that raise complex ethical questions for the research scientist and biodiversity manager: biodiversity and scientific uncertainty, techniques for studying and managing biodiversity, research in ecologically sensitive areas, and choice of conservation targets. The first case is presented in the greatest detail and comes closest to providing a full sense of the multi-layered nature of these ethical dilemmas. The other cases provide brief glimpses of the various types of ethical questions that arise in ecological research and management contexts.

Biodiversity and Scientific Uncertainty: Making Sense of Duties and Obligations

CASE: GLOBAL DECLINE OF AMPHIBIANS

Beginning in the late 1980s many amphibian populations declined and some species most likely have become extinct (Collins & Storfer 2003; Stuart et al. 2004). The losses were worldwide, but especially large in Central and South America and eastern Australia. Increasing evidence suggests a lethal fungal pathogen is spreading through some

amphibian communities in Australia and the Americas. Thirty years of records on amphibian declines and extinctions extending from Colorado through Arizona, Mexico, Honduras, Costa Rica, and western Panama lead to the prediction that there is an unknown, but finite probability, that tropical forest sites in central Panama will experience amphibian declines and likely extinctions when the lethal fungal pathogen reaches the area in 1 or 2 years.

The pathogen may not act alone and may need just the right environmental conditions to be lethal. And it may not reach central Panama and may not cause an epidemic in 1 or more years. How does one plan under such uncertain conditions? How do the various types and degrees of uncertainty surrounding the spread of the pathogen and its impact on sites in central Panama bear on the ethical questions surrounding this case? For example, in what ways are the obligations and responsibilities of the researchers, government officials, zoo curators, and conservation community strengthened or weakened by the range of predictive uncertainty in this case? How might different "infection and extinction" scenarios change or qualify the ethical obligations of the stakeholders and decision makers? How do we identify various obligations and responsibilities, and how can we construct and introduce clear and consistent ethical principles and frameworks to provide ethical guidance for making decisions in such cases?

A major component of predicting extinction is "decision making under uncertainty," and without the guidance of a framework for moving forward the default decision follows from the precautionary principle: "... to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (Principle 15 of the Rio Declaration, 1992 Earth Summit; see Groombridge & Jenkins 2002). Ideally, one should have an ethical, positive basis for acting as opposed to not acting because the way forward is not clear (Nature 2004).

Given that we anticipate that the pathogen will infect central Panamanian amphibian communities, the following are selected elements of the case related to stakeholder values and research questions. The list is not exhaustive, but indicates the kinds of ethical challenges being encountered.

What is the scientific community's role and responsibility given the possible imminent extinction of dozens of species? For example, should there be an effort to capture animals to breed, if possible, in zoos and perhaps in the pet trade? Should species with the greatest probability of breeding successfully be saved first? Or should the rarest species be saved even if nothing is known about their breeding habits? What happens to "excess" animals from

successful captive breeding? If the hope is to reintroduce frogs into native habitats, what happens if their welfare in habitats that are now infected by the pathogen cannot be ensured? If some species become extinct locally, should rescued animals from zoo populations be reintroduced if there are new species of competitors and predators? Fundamentally, are there, or should there be, ethical concerns about the potentially dramatic "intervention" of scientists and conservationists in the workings of the ecological community? That is, does respecting "wild" nature always entail a hands-off approach to ecosystems? If so, what if following this principle leads to species decline and extinction? If not, do the potential commercial implications and private nature of a conservation effort involving the pet trade degrade the value or integrity of the animals and ecosystem in an ethical sense? Or is preserving a species' lineage a value that trumps all other such considerations? What are the consequences of collecting animals for the research of investigators and their students working in the area? Is this even a consideration or, again, does the possible extinction of species supercede such concerns?

What is the conservation community's role and responsibility? Which elements of the national and international conservation community should be involved in this case? Are there likely to be different conservation agendas and different justifying values for any action taken in Panama?

What is the zoo community's role and responsibility regarding animal husbandry? What species should be collected, and why? How many of each species should be collected, and when should they be collected? Several frog species likely to become extinct in the wild are held in zoos and breed successfully to the point that surplus animals are killed, but these institutions are reluctant to provide animals for research on what might have driven the frogs to extinction for fear of the ramifications with donors and conservationists. Does the research community have a privileged position regarding excess animals for research if it could prevent further extinctions? What is the best way forward?

What are the administrative and policy communities' roles and responsibilities in this case? For example, should the government close and isolate the central Panamanian forest reserves with endangered frog species for fear that people may transmit the pathogen? What are the social, economic, and political impacts of doing so? Is closure justified when it is unknown how the pathogen moves among sites of infection? What is the role for the Panamanian public? What is known of their attitudes toward amphibians, conservation, and the possible management responses? What is their place in the decision-making process? Should Panamanian officials allow collection and export of animals to zoos in other countries? Should they facilitate such exports? What intellectual property rights must be considered relative to research that might uncover economically valuable products in the course of

seeking ways to protect the animals? Can Panamanian zoos handle the protection and breeding of these animals? If so, is this the best choice because the pathogen is in the country? Should zoo conservation be a priority if one can learn enough about the animals to protect them in the future?

Finally, should help be sought from the commercial sector (pet-trade community) to develop protocols for housing and breeding animals? Should this be allowed only if frogs could be reclaimed and released back into their natural habitats? Should an ecologist working on threatened populations raise alarms about fear of extinction from a cause like a pathogen? Doing so might expose the populations to commercial exploitation because species are more valuable commercially if threatened. If collectors were to acquire animals during an epidemic there is the risk of spreading the pathogen globally. Spix's Macaw (*Cyanopsitta spixii*) was driven to extinction by unsustainable collecting and habitat destruction (one male is alive in the wild). In what sense are we conserving biodiversity if a species lives only in captivity?

Ethical Questions Raised by Techniques for Studying and Managing Biodiversity

CASE 1: CONTROLLING RESEARCH RESOURCES

Exotic species are an increasing concern because of their effect on natural communities of plants, animals, and local economies. Various strategies, such as natural predators, poisons, or pathogens, are used to control common invaders (e.g., insects and plants). Recently, several exotic frog species became established in Hawaii. The coqui frog (*Eleutherodactylus coqui*) is so common now that noise from its nocturnal singing reduces home resale values and forces hotels to avoid using some rooms with nearby forest (<http://www.hear.org/AlienSpeciesInHawaii/species/frogs/>). Hawaiians would like to eliminate the frog, and some wildlife managers are considering releasing the amphibian pathogen discussed in the Panama case to kill the introduced species. Ironically, as some investigators study the fungal pathogen with the goal of conserving amphibian species, others want to use it for amphibian elimination. Researchers have not provided the pathogenic cultures, even for trials. But the investigators, in the course of publishing and as members of a research community, must eventually place the pathogens in a type culture collection where anyone, for a legitimate scientific reason, can withdraw samples. Eventually, then, resource managers where the frog is also a problem can go to the type collection for cultures. How long should a researcher with the original pathogenic cultures control access to collections given that it cannot be ensured another investigator would not give away the cultures? Can it be a condition of giving the cultures that they not be released for man-

agement? Should publishing results be delayed to avoid placing the culture in a collection?

CASE 2: USING GENETICALLY MODIFIED ORGANISMS TO CONSERVE AND CONTROL SPECIES

European wild rabbits (*Oryctolagus cuniculus*) from southwestern Europe are widely introduced into other countries worldwide and can be pests. Angulo and Cooke (2002) summarize a case with complexities that extend beyond those usually associated with deliberate release of genetically modified organisms (GMOs). Rabbits native to Europe support predators, including endangered Imperial Eagle (*Aquila adalberti*) and Iberian lynx (*Lynx pardinus*) populations. In the last 50 years rabbit populations have declined mainly because of the viral myxomatosis and rabbit hemorrhagic diseases. One solution being pursued is releasing a genetically modified virus based on an attenuated myxoma (MV) strain that protects against both viruses. Only a few rabbits must be vaccinated to immunize the larger population because the strain can be transmitted horizontally among rabbits in the field. The same rabbit species is an Australian pest. A control strategy being considered is releasing a genetically modified MV that reduces rabbit fertility through transmissible (virally vectored) immunocontraception; in other words, an introduced contagious virus would disseminate a contraceptive agent through the exotic populations of rabbits. This is not a solitary case. Opossums, foxes, cats, and rodents are also candidates for control by virally vectored immunocontraception (Angulo & Cooke 2002).

Some regulations focus on research and release of genetically modified organisms, but few agreements specifically address safe research, handling, and release of these organisms internationally (Angulo & Cooke 2002). What are the human, animal, and ecological consequences of releasing genetically modified MV? Is it wise to genetically modify viruses for conservation and pest control? Tyndale-Briscoe (1994) considers some of the ethical implications of this practice, but in general what are we to make of an applied research program for rabbit management with opposing goals: conserving a declining species in Europe and killing the same species in Australia?

Ethics of Research in Ecologically Sensitive Areas

CASE: SCIENTIFIC EXPLORATION AND ECOLOGICAL CONTAMINATION

Russian researchers are preparing to drill into Lake Vostok, a subglacial Antarctic lake buried under thousands of meters of ice. The lake, thought to have been isolated for 20 million years, might contain unique ecosystems and organisms that could greatly contribute to our understanding of Earth's climate history and that of early life on the planet. Although in the past environmental groups have opposed proposals to drill into Vostok's pristine ecosystems, the new drilling plan has drawn criticism

from other researchers in the international scientific community who are concerned that the Russian scientists' equipment will expose the lake to "unacceptable" levels of contamination (Gavaghan 2002; Giles 2004). The situation is further complicated by the fact that Antarctica is not a sovereign state but is rather a territory loosely governed by international treaties and scientific conventions. As a result, regulations are often ambiguous and difficult to enforce.

The Vostok drilling case raises many ethical questions; for example, Who (or what institutions or parties) decides whether it is right to sample such pristine—perhaps unique—ecosystems? How does one gauge the risks of contamination by the researchers against the potential knowledge gained by their research? What values and standards should guide the choice of an "acceptable" level of contamination by research instruments? Should there be ethical (in addition to technical and economic) restraints placed on the scope and reach of ecological investigation (i.e., are there some places we should not explore for fear of irreversibly harming or contaminating remote, fragile, or pristine ecological systems)? Does such a notion run completely counter to the progressive spirit of human scientific enterprise?

Values and Conservation Targets

CASE: CHOOSING BETWEEN PROTECTED AND ENDANGERED SPECIES

The declining desert bighorn sheep (*Ovis canadensis*) population in New Mexico prompted the state's game commission to pass a new regulation in 2002 allowing hunters to kill its primary predator, the mountain lion (*Puma concolor*) during the hunting season. Both animals are rare: The sheep are federally listed as an endangered species, and the mountain lion is a state-protected species. Critics of the lion management plan (including animal protective associations) argue that the kill quotas are too high and that hunting threatens the long-term survival of the population. Others argue that evidence of predation on the endangered sheep does not warrant the increased hunting quotas (West 2002).

Is it right to favor protection of the sheep over the lions in this case, or does this decision reflect an inappropriate and longstanding prejudice against predators? How much influence should stakeholders (e.g., hunters, animal protection associations, environmentalists) have in the decision-making processes of the New Mexico Department of Game and Fish compared with that of the department's (and nondepartmental) scientists? What should be the evidentiary standards for concluding that lion predation on sheep requires active management intervention? Should managers be compelled to pursue nonlethal lion population controls even if these are more costly and difficult to administer?

Other Issues in Ecological Ethics

In addition to the four general issues in ecological research and biodiversity management listed above, there are clearly many other issues and practices that provoke difficult ethical questions for scientists and conservationists. Further groupings of such concerns might include categories such as systematics and biodiversity management, resource commercialization, and scientific integrity. Of course, this list is not exhaustive, but it captures many of the types of ethical concerns that ecologists and managers often face in their work.

Ethical Tools for Ecological Problem Solving

Ecological researchers and biodiversity managers need to be able to seek appropriate guidance in answering questions such as those we posed here. In particular, they need to be able to identify and use relevant ethical principles and related considerations in problematic situations. Following the pragmatic insights of philosopher John Dewey, we hold the view that moral principles are best understood as tools for practical problem solving. The various expressions of value, duty, and obligation in these areas of ethical theory, that is, will prove useful in revealing the moral responsibilities in specific decision contexts and may be used as deliberative resources in the process of determining what should be done in concrete research and management situations (Dewey 1982, 1989; Minteer 2001; Minteer et al. 2004). This pragmatic approach places much greater emphasis on the process of moral reasoning and moral deliberation—the experimental rehearsal, testing, and revision of principles and decision scenarios in the imagination and public debate—than it does on the adherence to any single principle that might be thought of as uniquely authoritative or privileged in moral reflection.

Four primary domains of theoretical and applied ethics are the most relevant to the ethical questions raised by work in ecology and biodiversity management (Table 1): (traditional) normative ethical theory, research ethics, animal ethics, and environmental ethics. Each domain and its constituent principles may contribute to our understanding of the moral responsibilities of the ecological researcher and biodiversity manager to the public good, the scientific and professional community, and to individual plants, animals, and ecosystems. In our view, however, each tradition is limited to the extent that it typically highlights only a particular dimension of the moral situation.

For example, the discussion in environmental ethics focuses largely on establishing the moral standing of parts or processes of nature (e.g., nonhuman individuals, species, and ecosystems). Although this may help identify general obligations and responsibilities to natural parts and

Table 1. Elements of an ecological ethics framework.

<i>Ethical domain</i>	<i>Subject matter and general prescriptions</i>	<i>Representative work</i>
1. Normative ethical theory consequentialist ethics (utilitarianism) deontological ethics virtue ethics	doing right and being good in the human community choose that action or rule that produces the best consequences for all those affected uphold one's moral duties internalize and display the traits of good character	Goodin 1995; Bentham 1996; Hooker 2000; Mill 2002 Ross 1930; O'Neill 1989; Kant 1998; Hill 2000 Foot 1978; MacIntyre 1984; Aristotle 1998
2. Research ethics	scientific integrity, conflicts of interest in scientific research, public trust in science	Shrader-Frechette 1994; Elliott & Stern 1997; Hansson 2000; Shamoo & Resnik 2003
3. Animal ethics animal welfare animal rights	value of and duties to nonhuman animals reduce unnecessary animal suffering respect the dignity and/or moral and legal rights of animals	Frey 1983; Singer 1990 Wise 2000; Regan 2004
4. Environmental ethics weak anthropocentrism/ environmental pragmatism biocentrism ecocentrism	value of and duties to the natural environment conserve nature for nonconsumptive social ends (e.g., recreation, spiritual fulfillment, education, etc.), now and in the future protect living organisms for their inherent worth/intrinsic value protect whole ecological systems and processes for their "systemic" or intrinsic value	Norton 1984, 1987; Light & Katz 1996; Minteer 1998, 2001 Taylor 1986; Agar 2001 Rolston 1988, 1994; Callicott 1989, 1999

wholes in ecological research and biodiversity management, scientific researchers and biodiversity managers also have significant obligations beyond the duties that they may be said to owe to species and ecosystems. These include obligations to uphold scientific integrity and avoid conflicts of interest and responsibilities to the greater public good or welfare. These latter obligations may entail both "negative" duties such as refraining from any activities that may produce social harms and "positive" duties such as the protection and promotion of biological diversity and environmental quality for an array of human cultural values. In addition to traditional environmental ethical considerations, then, these other responsibilities may also figure prominently in the deliberations in reaching an ethical judgment about what should be done in a particular research or management context.

We believe a pluralistic ethical framework is therefore the best and most effective way to conceive of the moral resources required by practicing researchers and managers (Norton 1991; Minteer & Manning 1999). The primary task of creating this pluralistic framework lies with the identification and organization of practical ethical principles across the theoretical and applied ethics literatures in ways that will help ecologists and biodiversity managers delineate the moral aspects of specific research and management dilemmas. The framework would distill from this work multiple sets of moral principles—rendered in the form of clear prescriptive statements—relevant to ecological research and biodiversity management in the laboratory and field. Such statements should include both traditional normative ethical principles speaking to ecologists' and biodiversity man-

agers' duties to avoid social harms and promote the general public good (now and in the future), principles relating to their obligations to the scientific or professional community, and ethical principles speaking to their responsibilities to organisms, species, and ecosystems.

The best way to go about creating this framework is to form and cultivate a "deliberative community" of academic researchers and managers that can give shape to this new conceptual and practical tool kit. This community should be interdisciplinary and include ethicists, social scientists, research ecologists, and biodiversity managers tasked with exploring and debating the ethical dimensions of ecological research and biological conservation practices. The group would perform the creative functions of identifying and assembling a comprehensive ethical framework relevant to ecological research and biodiversity management and fulfill the critical role of providing peer review of this framework as a tool to aid moral deliberation and practical problem solving.

The resulting ecological ethics framework we envision will not produce absolute and definitive answers to the specific moral quandaries encountered in environmental research and management settings, but it would provide an important service by offering an instrument for clarifying and reasoning through the relevant principles and values that bear on problematic research and management situations. Still, one of the great difficulties that haunts any pluralistic model of ethics is the challenge of developing a method of integrating multiple principles, or, alternatively, of articulating one or more rules to direct the selection and application of one or more principles in particular situations. Along these lines, there have been

some important attempts by other interdisciplinary teams of scholars to identify and integrate, on largely a conceptual level, various environmental and social values and duties in conservation contexts. Two of the more notable examples are Shrader-Frechette and McCoy's (1999) "two-tier" method of moral decision making in conservation biology (incorporating both general utilitarian and deontological principles) and Mumford and Callicott's (2003) conceptual assimilation of multiscale environmental and community values, an analysis based on their study of stakeholders in the Great Lakes region.

Our own preference (keeping with our pragmatist leanings) is to emphasize the contextual and situational dimension of ethical integration and decision making within problematic research and management situations rather than the more conceptual aspects of this process. Ethical integration is not only a theoretical or intellectual activity (i.e., the philosophical assimilation of multiple values, duties, and interests) but also a form of practical reasoning, one performed by conflicted moral agents in complex and often morally and empirically ambiguous situations. We believe the most important "integrative" tasks in any sound model of ethical analysis are therefore action oriented and methodological in nature: improving individuals' sensitivity to the ethical context of specific practices (and their awareness of the relevant moral principles that bear on these practices) and facilitating the sharpening of individuals' imaginative and analytical skills so that they may learn to take a more reflective, creative, and systematic approach to moral problems.

This more pragmatic and "particularist" approach to ethics does not deny the role of general principles in ethical problem solving so much as it attempts to place them within a larger experimental process of moral deliberation and inquiry, a process that can also lead to the transformation of values as inquirers rehearse potential courses of action and share information and trade arguments with others over what should be done in specific environmental research and management contexts (Dewey 1982, 1989; Wallace 1996; Minteer et al. 2004).

Of course, such pluralistic and dynamic moral models are notoriously messy; principles can and do often come into significant conflict despite our best attempts to achieve either conceptual or pragmatic integration. In such cases, hard decisions will undoubtedly have to be made. At the same time, however, we should remember that there are often opportunities for moral deliberation to settle on practical actions and decisions that reflect the convergence rather than the divergence of different interests and values (Norton 1991; Minteer & Manning 2000). On this point there may be much to learn from established dispute resolution and "negotiated agreement" approaches (e.g., Fisher & Ury 1983; Susskind & Cruikshank 1987). Especially relevant to the vision of practical ethics we have outlined here are these methods' emphasis on the search for shared interests and mutual gain and

their focus on the development of novel tactics and solutions to complex problems through organized negotiation and consensus-building activities (Minteer 2004).

Finally, in addition to creating a pluralistic ecological ethics framework, our proposed project leads to the preparation of a wide-ranging set of case studies in ecological research and biodiversity management (such as more developed versions of the kinds of cases presented above) that would become a useful database for scientists, managers, and students interested in learning how ethical questions emerge in the course of field and laboratory practices and about the moral claims that may be placed on them in a given situation (e.g., Dubycha & Geede 2003). As we have witnessed with the rapid growth of the field of bioethics, such a case database can be an important educational and analytical tool, sharpening our understanding of ethical issues, our critical thinking, and our problem-solving skills (e.g., Crigger 1998; Murphy 2004; Pence 2004).

The development of a similarly detailed and organized case literature in ecological ethics would allow scientists, managers, and students to compare a variety of ethical, research, and managerial issues across experiential and value contexts, and would provide them with an opportunity to learn from the specific differences and similarities of the issues and cases. Such cases, developed as full educational modules complete with discussion questions, background readings, and supporting materials, could then be housed on a Web site that would serve as an integrative focus for interdisciplinary work and dialog in this new area of practical ethics. Through these kinds of activities we hope to facilitate the interdisciplinary conversation and preparation of the ecological ethics "tool kit" for environmental researchers and managers.

Conclusion

We call for a new approach in practical ethics—"ecological ethics"—and a new conceptual and analytical tool kit for ecologists and biodiversity managers that will help them deal with the moral questions raised by their work. These questions have to date not been addressed in a systematic fashion within the established areas of applied ethics. A comprehensive ethical framework and case study database is therefore needed to help research scientists and biodiversity managers better understand and respond to the ethical issues they face in their research and conservation activities. These tools not only will provide critical assistance to researchers and managers as they deliberate within specific decision-making contexts but also will ultimately help create a larger and necessary forum for discussion of the complex ethical dimensions of ecological research and conservation practices.

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