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The following three essays are part of a series on teaching bioethics, edited in collaboration with the Presidential Commission for the Study of Bioethical Issues.

Why Training in Ecological Research Must Incorporate Ethics Education

BY G.K.D. CROZIER AND ALBRECHT I. SCHULTE-HOSTEDDE

Although we come from different disciplines and faculties—one of us is an evolutionary ecologist; the other, a philosopher of the life sciences—we share an interest in the ethics of biological science. The philosopher, G. K. D. Crozier, has taught bioethics to honors biology students, and the ecologist, Albrecht I. Schulte-Hostedde, integrates ethics sections into his graduate courses and serves on the Board of the Canadian Council for Animal Care, the national organization that oversees the ethical use and care of animals in science. When we met in 2011, we started investigating how ecological researchers contend with the ethical dimensions of their field studies. In 2013, at the Annual Meeting of the Canadian Society for Ecology and Evolution, we conducted a workshop and survey of ecological researchers regarding the ethical dimensions of their work, and since then we have had numerous communications with researchers about their personal experiences. These communications confirmed our expectations: they convinced us that ecology should have ethics integrated into its graduate training curricula.

Historically, biological researchers have held considerable skepticism, if not downright animosity, toward ethics because of the association between ethics and animal rights activists.¹ The only place that any ecologist might formally encounter ethics issues has been when working on vertebrates

or cephalopods and in the animal care infrastructure and organizational structure associated with animal welfare and the use of animals in science. As one anonymous respondent to our survey put it, "People studying biology are particularly illiterate in ethics since students with ethical concerns about use of animals are steered to other nonscientific fields. Such concerns are viewed as invalid. In fact, it is often the case that 'we' (ecologists) are ill informed. Discourses of ethical concerns for animals remain largely taboo (but things are improving)." We have been pleasantly surprised, however, by the amount of support for ethics education we have found within the ecological research community.

Ecological Research

Ecology is the branch of biology devoted to the relationships among organisms in the wild and between organisms and their environments. Ecological research scientists work in universities, governments, nonprofit organizations, and industry, and they study a broad range of topics, including, for example, the population dynamics of other-than-human organisms, including endangered species; the impact of industrial pollutants on wild populations; and the evolution and dispersal of wildlife diseases, including diseases that are transmissible to humans (zoonoses).² When we use the term "ecologists" in this essay, we refer specifically to scientists in the field of ecological research rather than to forest or wildlife managers, environmental policy-makers, conservationists, environmentalists, and so on (although members of these

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Rapidly changing local and global environments mean that ecologists will be on the front line of any efforts to create a sustainable lifestyle for humans on this planet.

groups overlap and their work is interrelated). Our arguments are specifically about practicing scientists and the discipline of empirical ecological research.

Like other science, technology, engineering, and mathematics fields, ecological research needs ethics. Given the rapid pace of technological developments and social change, it is important for scientists to have the vocabulary and critical-thinking skills necessary to identify, analyze, and communicate the ethical issues generated by the research and practices within their fields of specialization.³ Good science is often *good* science, which is to say that science done well is very often science conducted ethically. At the very least, science done poorly wastes valuable resources and cannot be responsive to the needs of the public, by whom much research is funded. This is true in all science, technology, engineering, and mathematics fields but especially so in biological sciences, which are intimately connected with the challenges of human health and well-being. The goal of introducing ethics education for ecological researchers would be to promote a discipline in which scientists are willing and able to engage in ethical questions and problem solving, even if they do so inadequately at first.

Practicing ecologists ought to be able to identify and critically evaluate the ethical dimensions of their field studies because ecologists are at the forefront of important interfaces between humans and other-than-human organisms and natural systems. They are among the first to identify the impact of anthropogenic changes to the environments, such as agricultural management practices that introduce livestock waste into wilderness areas⁴ or highway development projects that result in habitat fragmentation for threatened species.⁵ Rapidly changing local and global environments mean that ecologists will be on the front line of any efforts to create a sustainable lifestyle for humans on this planet.

Ethical Issues in Ecological Research

In an ideal world ecological researchers would have unlimited resources, both financial and human, with which to study ecosystems across the globe. Their interactions with policy-makers, wildlife managers, and local human communities would be transparent, and information flows would be frictionless. Furthermore, there would be no tension between activities needed to study a natural ecosystem and those that would best preserve it.

The real world is, of course, much more complicated. For one thing, ecologists have to be selective about which research projects they undertake and how extensive to make them.

These decisions cannot be made on purely objective scientific criteria but, rather, must be informed by the perceived value of the information to be discovered relative to available resources.⁶ Additionally, the interactions between ecological researchers and policy-makers, wildlife managers, and local human communities can be fraught with communication challenges and political cross-purposes.

For example, a grant-funded field study to examine rare and endangered species of reptiles on Pelee Island in southern Ontario was halted because of the concerns of local residents. The project was a collaboration with the provincial government, and the local residents feared that the discovery of rare or endangered species on their own or adjacent properties would limit economic development opportunities administered by the province. This led to strong open hostility toward the ecological research team by local residents. Despite a presentation to the town council explaining the relatively limited scope of the study, the local community's resistance to the study remained and the project was terminated—in part to prevent any risks to the physical safety of the researchers.⁷

Even when the implications of ecological research are not negative for the local human communities, it is rarely un-complicated.⁸ In Northern Canada, for example, researchers working on migrating birds have found the local ecological knowledge of First Nations communities to be indispensable in establishing historical information about population distributions.⁹ However, when the empirical claims arising from the knowledge of local communities conflict with those arising from ecological research, it is less clear how to proceed. This concern has arisen, for example, in predictions of the size of polar bear (*Ursus maritimus*) populations near the Arctic Circle; ecological research predicts these populations are so small as to be threatened, whereas local Inuit traditional knowledge (Inuit *Qaujimajatuqangit*) indicates that these populations are much larger than ecologists surmise.¹⁰ Although ethics is not the only extra-ecological consideration required to adequately address scenarios such as this, it is one significant component.

Ecological research almost inevitably requires manipulation of the ecosystem being studied: sometimes the impact is minimal, such as when behavioral observations are made from a distance, but often it is not. Decisions that might produce the best scientific results with the least human resources might require a set of experimental procedures that cause considerable harms to the individual organisms or ecosystems involved or even to other local biota.

A forty-year study of bighorn sheep (*Ovis canadensis*)¹¹ on Ram Mountain in Alberta, Canada, raises important

questions about researchers' manipulation of the ecosystem. This study was recently threatened by a cougar (*Puma concolor*) that specialized on preying on the sheep. Elsewhere, we have discussed an ethical dilemma faced by the research team, which had to decide whether to have the cougar shot to preserve the viability of the study.¹² Since we first wrote about this case, we have learned that the predation suddenly stopped without any intervention by the ecologists, who assume that the cougar died. While this fortuitously absolved the researchers from making a decision about removing the cougar, it does not preclude us from speculating on what an ethical decision-making process might need to consider.

One thing the ecologists were keenly aware of is that the study itself included all factors affecting these populations under ordinary circumstances, including trophy hunting, varying food supplies, and natural predation; this consideration would indicate that interfering with the cougar's predation might run contrary to the very aims of the long-term study. However, this predator threatened not only the sheep population but also the future of the study itself and the value of the data already collected. One might, however, reasonably question whether an anthropocentric frame is even appropriate in evaluating the ethics of this particular decision: should the needs of the researchers or the value of the study to science be given primacy in this decision-making process at all?

It is not the case that easy consensus exists within the field of ecology on ethical issues, in the rare cases when they are discussed. When ecologists from Arizona State University and Plymouth University recently published a short letter in *Science* warning that the standard practice of collecting "voucher specimens" to confirm the existence of isolated or rare species should be curtailed for ethical reasons, it raised a flurry of controversy in the scientific community.¹³ The letter argued that, when species are rediscovered after having been previously considered to be extinct, the practice of collecting samples of the species to verify its continued existence risks overstressing and thereby endangering the population; it contends that the scientific value of having the specimens of rare or endangered species stored in archival collections might be outweighed by the ethical obligation to maintain these possibly reproductively viable organisms in the natural population. In place of the collection of whole organisms as specimens, these ecologists recommend nonlethal data gathering, such as DNA samples and photographs. This sparked a lively debate in the ecological research community,¹⁴ with a series of articles and social media publications—including one essay coauthored by over 120 scientists,¹⁵ as well as numerous blog entries, Tweets, and YouTube videos. Many ecologists defended the ethical legitimacy of the practice of lethal sample collection on the grounds that the practice has, historically, been sufficiently safe for endangered and threatened populations and that, in the future, it will be critical for obtaining the data needed for species conservation.¹⁶

On the horizon of this debate lies the question of under what circumstances lethal sampling of organisms is permissible in the pursuit of ecological research. We have learned

through personal communications with ecologists that, while they might not pause to kill large numbers of nonanimals (such as plants) or invertebrates (such as soil nematodes) during the course of an experiment, they would hesitate to do the same to vertebrates. It is not self-evident, however, under what circumstances ecologists might be ethically bound to curtail lethal sampling when alternative methods might obtain sufficiently rigorous results, even if that would require that they invest more time and other resources.

Consider the contrast between two ecological field studies, both undertaken to determine the effect of warbler population density on fecundity, among other factors.¹⁷ In one study, the researchers opted for a method involving shooting an undisclosed number of warblers to artificially reduce the density of birds in one population.¹⁸ In another study, the researcher opted not to kill warblers and instead relied on data drawn from natural population distributions.¹⁹ While this latter, nonlethal method was more resource-intensive, requiring indirect measures of the properties of interest, good results were obtained. In the fields of philosophy and bioethics, there are multiple ethical arguments by which such decisions might be rationalized or contested, some more justified than others²⁰—but such arguments are not made available to ecologists as part of their training or culture.

The Need for a Culture Shift

Without a doubt, ecological researchers have to make important ethical and value-based decisions in their work. To meet these challenges, we believe that ecological researchers must receive ethics training to promote a culture wherein ecologists actively engage with and discuss ethical questions arising within their research. If they are not provided with the vocabulary and conceptual resources to reliably identify and analyze the ethical questions that emerge in their field studies, they will find it difficult or impossible to communicate these concerns and to develop ethical best practices, which need to be grounded in evidence and experience. This is particularly concerning given growing consensus on the close link between human health and the environment, seen for instance in the One Health Initiative to foster interdisciplinary connections across fields relevant to human, veterinary, and ecosystem health.²¹

Despite its particularly acute need for ethics literacy, ecological research has been lagging behind other biological fields, such as biomedical sciences and genetics, in integrating ethics training and communication into the field. In our 2013 survey of ecological researchers, only 8.7 percent reported having themselves received ethics training at the graduate or postdoctoral level, yet 83.3 percent reported that they believe ecology students should receive some ethics training. Of particular concern to respondents (to 87.5 percent of them) were the benefits that ethical reasoning in ecological research can have for increasing coherence and consistency of practices within ecology.

Ecologists must be trained to think ethically about the impact of field studies on not only other-than-human organisms and populations but also ecosystems and human communities.

We have participated in several discussions regarding the ethics of field experiments where it has become clear that many ecological researchers are eager for the opportunity to identify and discuss the ethical dimensions of their field studies. One exchange focused on the ethics of intraspecific translocations, where organisms are taken to new habitats to observe them under novel environmental conditions. The motivating question was what (if any) practices ought to be enacted following the conclusion of translocation studies in order to ensure that the transplanted individuals are removed. The ecologists debated whether there is a duty to future generations of ecologists to protect the genetic integrity of these habitats, how “cleanup” practices might have to differ when the transplanted individuals are animals rather than plants, and what implications these practices might have in cases where it is deemed that “genetic rescue” is needed for a wild-life population in peril of becoming inbred. The ecologists involved were eager to discover what practices the others used and why and how these might inform ethical “best practices.” Providing ecological researchers with ethics training can ensure that space will be created for discussions such as this to become more habitual rather than a rarity in the discipline.

Strategies

To meet these challenges, we believe ecologists have to be at the forefront of the move to promote ethics literacy and communication. We recommend that ethics education for ecologists be primarily targeted at graduate education, but we also call for training and guidance for established professionals.

For ethics education to be effective, it should, at minimum, satisfy three criteria, the first of which is that it involve training in how to think ethically about the impact of field studies on not only other-than-human organisms and populations but also ecosystems and human individuals and communities. This is because the work of ecological researchers has close connections with the decisions of policy-makers, wildlife managers, and the communities located near ecological field studies.

Second, this training must be integrated across the curriculum because the practice of ethical reasoning is an ongoing one. This means that, rather than having a single module per degree or per year wherein students consider the ethics of ecological research, they should be guided in how to incorporate ethical reasoning into evaluating field study designs on an ongoing basis. If ethics is not integrated but is instead

introduced as a stand-alone module, students will find it difficult to develop the nuanced, practical skills required for applying ethical criticism to ecological research in the varied contexts where they are likely to need it. Moreover, they will be encouraged to consider ethics as a short-term obstacle to overcome rather than a method of critical reflection that needs to be applied consistently and continually.

Finally, there are several reasons that ethics training should be undertaken with the assistance of nonecologists, such as bioethics and philosophy scholars. First, given the current shortage of ethics expertise among ecological researchers, there is an incontrovertible need for the involvement of ethics specialists from other disciplines in the early phases in order to transfer the vocabulary and conceptual apparatus of ethical reasoning into the hands of the community of ecological researchers. And even once a sufficient proportion of the ecology community has developed the technical ethics expertise to take over the ethics training of graduate students, it will still be important that people from outside the field of ecology be involved. This is because in-house-only ethics education would risk insulating the ecological field from the society in which it functions.²² As we have indicated, the ethical dimensions of ecological research have implications for not only other ecologists but also for other groups, including local human communities and the greater public. Therefore, including nonecologists in the education of ecology grad students on an ongoing basis will be an important mechanism for encouraging awareness among ecologists of these considerations.²³

Although we advocate graduate school as the primary locus for targeting ethics education in ecologists, additional training modules should be developed for professional ecologists already working independently in the field. Additionally, other strategies for bringing together ecologists and bioethicists are in order, including the development of professional codes of ethics for ecologists with the assistance of scholars from across disciplines.

In Canada, for example, while multiple policies and regulations exist for regulating various aspects of the work ecologists do, there exists no comprehensive ethics policy governing the field; consequently, many of the ethical dimensions of ecological research fall between the cracks. This is demonstrated by the problems arising with certain whole-ecosystem experiments, such as that in Northern Ontario's Experimental Lakes Area. Established in the 1960s, this area consists of fifty-eight lakes where ecologists are able to conduct long-term and whole-ecosystem experimental

manipulations.²⁴ Research on these initially pristine lakes has resulted in numerous important breakthroughs regarding anthropogenic environmental change, including acid rain, algal blooms, and climate warming.²⁵ Of interest to our discussion, in particular, is the impact that so-called whole-lake experiments can have on organisms that are not the direct subjects of the research project.

Because human hormones have been making their way into natural water systems through untreated or insufficiently treated urban wastewater, one team set out to determine the impact of estrogen on fish. They conducted a whole-lake experiment that involved introducing estrogen to the water and measuring changes in the gonads of fathead minnows (*Pimephales promelas*) in the lake. As expected, the estrogen caused the male minnows to feminize, and this threatened the viability of the minnow population. Interestingly, while the researchers would have been required to obtain approval from an animal ethics committee for the use of the minnows, the impact of this field experiment on other organisms that use that lake need not be considered; this is because only those animals directly handled by the researchers are considered relevant to animal care and use committees. This demonstrates one of the ways in which ethical issues are not comprehensively covered by current regulatory and policy standards.

To address this, we are working with the Canadian Society for Ecology and Evolution and economist Paul Hansen—who has codesigned the decision-making theoretic survey tool 1000Minds²⁶—to develop a framework for a code of ethics for Canadian ecologists grounded on the values of their community.²⁷ It is our hope and expectation that this code will serve as a catalyst for discussion within the ecological community, promoting fruitful interactions between ecologists and ethics scholars. Furthermore, this ethics code can help structure ethics education for ecologists, targeted not only at graduate education but also for additional training sessions and workshops for professional ecologists already supervising their own teams. At present, bioethicists and ecologists rarely interact, and more interaction between these groups—through multidisciplinary conferences, workshops, advisory boards—needs to be encouraged.

We also believe that it is important to solicit the input of other stakeholders—not just ecologists but also, for example, local and First Nations communities whose lands and livelihoods intersect areas where ecologists conduct field studies. Survey tools such as 1000Minds might not be an ideal method for collecting data from these communities, so while this theoretical construct is a good starting point, broader strategies will be needed to incorporate more relevant information to reflect what people value.

There is no way around it: ecologists are making ethical decisions all the time, but they are doing so on an ad hoc basis. This is suboptimal because it leads to arbitrary decisions and therefore inconsistencies across researchers and projects, and it also serves as an obstacle to the development of ethical best practices in ecological research. Additionally, there is a need to build self-awareness in ecologists that there are

ethical issues in their work that go beyond animal welfare issues. Consequently, there will have to be some considerable effort to change this about their culture, and ethics training for ecologists needs to be an integral part of any strategy to improve ethically salient decision-making in the field.

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Teaching Bioethics at the Secondary School Level

BY LAURA J. BISHOP AND LOLA SZOBOTA

By nature, bioethics issues offer an innovative way to engage students in the subjects traditionally taught in high schools; teach them a range of skills, including research, argumentation, writing, and public speaking; and expose them to a variety of career opportunities. Bioethics is accessible to students across the range of learning abilities and often rouses new interest in a subject. Discussions about bioethics issues permit teachers and students to engage one another in genuine conversations about issues for which there usually is no one right answer and about topics on which all participants are learning and thinking together.

Another reason bioethics is a wonderful subject for high school students is simply that it addresses big questions.

Adolescence is the time when big questions about the value of life, the significance and purpose of human endeavor, one's responsibilities and obligations toward other people and other animals, and one's place in the world begin to surface for people. It is also a time when young people often need to—and do—make important decisions with bioethical implications. High school students already have or will face bioethical questions in their personal, family, and civic lives. Judgments about the direction and reach of science using the analytic tools of ethics and the law are exactly the judgments that citizens will be called on to make to help establish public policy and that individuals must make in private for themselves and their families. The methods of thought and discussion in bioethics and the ability to research to find the trustworthy knowledge required to understand bioethics cases can help students learn strategies to arrive at answers that

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