

Planning an invasion

Part I

Eric is a postdoc studying dispersal and colonization of new habitats. He is interested in the microinvertebrate community of small ponds and wants to assess the role of dispersal and colonization in assembling communities. After all, a species may be absent from a community not because it can't persist there, but because it just hasn't arrived there yet. His plan involves collecting animals from a few dozen ponds in the region, mixing them together in a cattle tank, and then inoculating 24 ponds with a sample of the total regional species pool. All ponds involved in the study have similar physicochemical characteristics, and there is no apparent reason why their species compositions should differ. The ponds he plans to inoculate are all in the Reagan National Forest, which is at the center of the region. Eight of the ponds were used by Derek, a recently finished PhD student in his lab, who was studying the strength of food web interactions.

Q What ethical issues, if any, does Eric's plan raise? Who else could be affected by his research? Is it okay for Eric to manipulate the communities to suit his research needs?

Part II

Eric's work has moved him naturally into invasion ecology. He is interested in a particular species of zooplankton, *Diastocus eatseverythinginsighti*, which is invading the US in a wave from New Orleans. He is working on a proposal to study the invasion of *D eatseverythinginsighti* across North America. It has been progressing northwards at about 75–150 miles per year for the past 5 years. Eric is presenting a draft of his proposal to his department's Ecolunch group.

Don, a grad student in another lab, starts the critique: "Okay, Eric, you've convinced me that the invasion of this critter could pose a problem for aquatic communities. But you're proposing to deliberately introduce it to 48 lakes on a latitudinal gradient from Louisiana to Wisconsin. You can't do that!"

"Well, sure, it will be complicated, but the payoff is huge", replies Eric. "Manipulative field experiments are desperately needed to understand large-scale invasion patterns. Too much work on the effects of invaders is just correlation or took place in the lab." Baffled, Don replies, "Maybe so, but you still can't do it. It's just plain unethical!"

"What do you mean?", asks Eric. "I'm not doing anything that isn't going to happen eventually. If *D eatseverythinginsighti* is going to succeed or fail in any particular new lake, it doesn't matter whether I put it there or it gets there on its own. And I'm not giving it any help that it won't get from fishermen soon enough."

Q Who's right, Don or Eric? Imagine that you're on an NSF review panel, and Eric's proposal is one of the best, scientifically speaking. It is sound research that addresses important questions basic to invasion ecology. Will any ethical concerns influence your recommendation to fund or not? What if the proposal were only borderline fundable?



■ Commentary on "Planning an Invasion"

Manipulations of the environment have played a crucial role in the advancement of ecological understanding. These include widely known major manipulations, such as whole-lake acidifications, clear-cutting watersheds, and poisoning the insect community of a rainforest canopy. At the other end of the scale are minor actions such as tagging trees, taking water samples from lakes, observing fish while snorkeling, or excluding pollinators from some individuals in a population. In the former situations, the manipulations are so extreme that it would be difficult for researchers not to recognize a potential for

damaging the environment, and we assume they concluded that the benefits gained outweighed the potential damage. In the latter situations, the potential for affecting the environment is so small that researchers may not even think of them as manipulations.

This case is designed to address the question "Under what conditions is manipulating the environment to advance science ethical?". The two parts of the case are aimed at different potential harms. In Part I, we consider whether field manipulations could interfere with the research of others, thus harming ongoing scientific work. In Part II, we ask what

constitutes an acceptable risk for damage to the environment.

In Part I, one issue involves the potential effects of Eric's projects on other researchers, although the list of parties who could be affected by Eric's research includes several other people. If Eric moves animals around to a number of new ponds, this potentially compromises the work of future researchers, by interfering with their expectation that the environment is largely unaffected by people. The degree of potential harm depends on how closely other researchers' questions would be affected by the manipulation in question, and the degree to which their importance relies on being evaluated in a "natural environment". In this case, Eric's proposed manipulations could reasonably affect any plans Derek has for building on his results with new work on the same ponds he used before. The obvious solution, given that Eric and Derek are affiliated with the same lab, is simply to ask Derek what his future plans are and to coordinate efforts to avoid conflicts.

This issue is more problematic when the wider scientific community is considered. Eric simply cannot foresee all the potential researchers who might be interested in these particular ponds. Things may be somewhat easier if the ponds are part of an area that has been historically used for research by a particular institution. In that case, there may be a coordinated archive of all local research, or at least an institutional memory. Eric could also minimize possible harms by seeking to remain active with the local research community after his postdoc, marking nearby trees, and publishing sufficient detail (such as GPS coordinates) so that others can determine which ponds were actually manipulated.

Another possible outcome is damage to the sampled populations, and thus the case illustrates a conflict between two values: scientific advancement and environmental preservation. The conflict between these two values is inherent in any ecological field experiment. Obviously, the consequences for the ponds to which Eric plans to introduce animals are unknown, otherwise the experiment wouldn't be worth doing. Some consequences may be viewed negatively: food webs may be destabilized, some species could be driven locally extinct, pathogens might be spread, etc. These may be acceptable risks in experiments done at a modest scale, but their consideration helps understand more complicated situations. What reasonable actions minimize these risks without compromising the scientific objective? Understanding that even commonplace experiments implicitly involve choosing between different values is an important step towards being able to evaluate ethical dilemmas.

In Part II, attention is focused on whether particular manipulations can be considered unethical on the basis of possible harm to the environment and, if so, what factors should be evaluated to make determinations in particular cases. It may help the discussion if the leader prepares in

advance a list of environmental manipulations that progressively have greater and greater damage potential, keeping in mind the types of manipulations the participants carry out in their own research. One approach to discussion is to list the different ways in which a particular manipulation could harm the environment, and whether any of these harms have consequences for humans.

This case is directly related to Principle #6 from the Ecological Society of America's Code of Ethics: "Ecologists will conduct their research so as to avoid or minimize adverse environmental effects of their presence and activities..." (see <http://esa.sdsc.edu/codeofethics.htm>). This principle explicitly recognizes the conflict between increasing our scientific understanding and the possibility that, in the process of doing so, we may damage the environment. To truly minimize adverse effects, one would have to refrain from any field experimentation, so this principle indicates that we need to evaluate both the possible costs and benefits of our research, and the likelihood that those costs and benefits will manifest themselves.

We don't specify what effects the invading species Eric wants to study has had on the lakes it has already invaded, but its name suggests it isn't benign. Do your views depend on what is known about the effects *D eatseverythinginsighti* has had in lakes it has already invaded? If its effects are notably negative for either the ecosystem (say, it accelerates eutrophication) or for recreational use (the bass populations collapse, perhaps), does this make Eric's research more urgent? Or more dangerous? What level of environmental damage risk is severe enough that we should restrain our scientific objectives?

Eric is apparently aware that his research could have bad consequences for the lakes he uses, and justifies this by saying it will happen anyway. How much evidence does Eric need before this is a reasonable expectation? Assuming that it is true that the invader will reach Wisconsin anyway, is that a reasonable justification?

As a subsidiary issue, this case asks whether the ethics of environmental manipulation should be a consideration in funding decisions. Other ethical issues already are a factor (research on vertebrates and humans), but are typically handled by obtaining approval from a local committee. How should potential environmental harm factor into funding decisions? There may be a balance between the potential harm, the importance of the work, and the quality of the work proposed, that needs to be evaluated before a reviewer can make a responsible funding recommendation. Since public outrage in the wake of scandals has imposed an ethics component on funding in animal and human research that can result in cumbersome bureaucracy, it may be prudent for ecologists to begin incorporating environmental ethics into funding decisions voluntarily.