



The role of ethics in experimental marine biology and ecology

Helene Marsh^{a,*}, Richard Kenchington^b

^a*School of Tropical Environment Studies and Geography, James Cook University, Townsville, Queensland 4811, Australia*

^b*Maritime Policy Centre, University of Wollongong, Wollongong, New South Wales 2522, Australia*

Received 1 November 2003; received in revised form 15 November 2003; accepted 17 November 2003

Abstract

Although most countries have ethical guidelines for research involving human subjects and other sentient animals, the ethical issues associated with field research have received little attention. Most experimental marine biologists and ecologists operate without ethical guidelines or scrutiny, despite intermittent community concern about their activities. We offer suggestions on how marine biologists and ecologists can protect the future of research involving the field collection and experimental manipulation of organisms by developing mechanisms to address community concerns that such research is ethically responsible. We urge experimental marine biologists and ecologists to take pre-emptive initiatives by encouraging: (1) institutional animal ethics committees to broaden their terms of reference to include environmental ethics; (2) scientific societies to develop codes of ethics to guide the environmental research conducted by their members; (3) editorial boards of journals to require the research they publish to conform to an appropriate code of ethics, and (4) management agencies that issue permits for field research to establish an ethics committee to advise them on the ethical issues raised by specific research proposals. We conclude that the resultant administrative burden on scientists would be low but that the penalties of operating without such protection can be high.

© 2004 Elsevier B.V. All rights reserved.

Keywords: Ethics; Experimental marine biology; Experimental ecology; Field experiments

1. Introduction

On the 18th of December 1996, the national parliament of Australia agreed by a majority of two votes to the changes in the zoning status of reefs required for a large-scale experiment in marine ecology ([Commonwealth of Australia Gazette, 1996](#)). National parliaments are

* Corresponding author. Tel.: +61-747-815575; fax: +61-747-816126.

E-mail address: helene.marsh@jcu.edu.au (H. Marsh).

not usually required to approve such experiments, but this one involved opening and closing individual reefs to assess the impact of line fishing on reef fishes and other biota. Changes in the zoning status of reefs in the Great Barrier Reef Marine Park must be approved by the Australian parliament (Lawrence et al., 2002). This requirement resulted in the ethics of the experiment itself being hotly debated in both the media and the parliament.

Opponents of the experiment alleged that the environmental harm done by the experiment would be equivalent to the logging of old growth forests. Most marine ecologists were deeply concerned about the associated threat to the future of experimental field research, but bemused by the controversy itself. The experiment planned to open and close reefs to fishing in a controlled way to allow scientists to measure the effects of different fishing regimes on target fish populations and reef communities (Mapstone et al., 1996). It was just the sort of large-scale experiment in adaptive management that had been strongly advocated in the scientific literature (e.g., Walters and Green, 1997). Fishing is one of the multiple uses of the Great Barrier Reef region and in 1996 was allowed on 80% of the reefs within the Great Barrier Reef Marine Park. The techniques to be used to catch the fish during the experiment are used legally by commercial fishers in the Great Barrier Reef Marine Park on a daily basis. In addition, opportunities for revision of Great Barrier Reef Marine Park zoning had been foreshadowed since the Park was established (Lawrence et al., 2002).

The public controversy generated by this experiment illustrates a challenge that experimental marine biologists and ecologists must address if manipulative field experiments are to continue, especially if they are planned for sensitive and protected areas. Although most countries have ethical guidelines for research involving human subjects and other sentient¹ animals, these relate primarily to the individual experimental subject. The ethical issues associated with field research (and laboratory research involving lower vertebrates and invertebrates) have received much less formal attention. There is typically little requirement for specific consideration of the broader implications for biological diversity of proposed experimental treatments as they may relate to factors such as the status of populations, habitat integrity or inter-species community dynamics such as predator/prey interactions. As a result, most experimental marine biologists and ecologists operate without ethical guidelines or scrutiny, despite intermittent community concern about their activities in response to specific controversies such as that outlined above. In this essay, we offer suggestions on how responsible marine biologists and ecologists can protect the future of research involving the field collection and experimental manipulation of organisms by developing mechanisms to address community concerns about the ethics of manipulative experiments.

2. Considerations for environmental managers

The life cycles and interactions of most species in marine ecosystems are remote, strange and invisible to people used to life on land (Kenchington, 1990). As an outcome of

¹ Having the capacity to perceive through the senses. Usually refers to a higher animal with the capacity to be aware of its environment on other than a purely chemical level, in a manner similar to human beings.

their research, experimental marine biologists and ecologists have identified and evaluated changes in marine ecosystems and have explained and interpreted these changes to people who can not see or experience them first hand. Scientists have played key roles in calling for protection of marine species and ecosystems and advocating management responses such as the establishment of global representative systems of Marine Protected Areas (Kelleher et al., 1995) and the creation of World Heritage sites and Biosphere Reserves.

Management of marine ecosystems is usually based on the identification and protection of values of biological diversity and habitat. In the Great Barrier Reef, for example, the duty of the Marine Park Authority is to protect the outstanding natural values of the Great Barrier Reef World Heritage Area. There is an obligation for the managers to ensure as far as practicable that permitted activities do not threaten those values. This raises the responsibilities of design, conduct and management of research to ensure that likely impacts on populations, sites and habitat integrity are addressed, minimized and appropriate.

3. What constitutes an ‘ethically appropriate’ field experiment?

In the context of this essay, ethics is about determining what is appropriate and inappropriate behavior (ASTEC, 1998). The problem for us as experimental marine biologists and ecologists is that no-one has defined ‘appropriate’ behavior for much of what we do, outside of experimenting on sentient animals.

An additional problem is that the definition of ‘appropriate’ changes over time and is different in different cultures. Even in the same culture, community expectations are constantly changing (Beale, 1998). For example, the authors were both undergraduate students in the 1960s in Australia and the United Kingdom, respectively. Along with every other individual in our large classes, we were required to make an extensive field collection as part of our undergraduate curriculum and were rewarded for collecting and preserving rare specimens. The students in Australia were formally taught to do this using indiscriminately destructive techniques such as sprinkling rotenone over a parts of a coral reef lagoon. Such behaviors would be considered ‘inappropriate’ by most field ecologists today.

However, there has been surprisingly little public or scientific discourse on the topic of what is ‘appropriate’. Rather, there has been an assumption that as scientists, we know what is ‘wrong’ to do and can keep up with changing community expectations. Sometimes we misjudge community attitudes as illustrated by the controversy over the Effects of Line Fishing experiment above. The wider community was also outraged over an experiment to measure the short and long-term effects of anchor damage on coral that was planned for a reef in the Great Barrier Reef region. This work had to be abandoned when the community refused to endorse what they saw as gratuitous harm to a coral reef in the name of science (Beale, 1998). The fact that the damage to be inflicted under experimental conditions was trivial in comparison to that caused incidentally by the public every day was irrelevant. This controversy forced a PhD student to modify his research topic after several years’ candidature at considerable personal and some institutional cost.

In a thoughtful essay, [Farnsworth and Rosovsky \(1993\)](#) propose that the general 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 negative impacts of our work; (4) tacit assumptions about certain experiments that are simply wrong to do'. They encouraged dialogue between scientists and philosophers on this issue with a view to establishing standards of self-governance under the aegis of the scientific community.

However, our review of the literature suggests that such dialogue has generally not occurred and that the most effective response has been generated by management agencies in response to public controversies such as that which surrounded the Effects of Line Fishing experiment as discussed above.

4. Has the scientific community established effective standards for self-governance in field experimentation?

Because judgments about the quality and merit of research are determined mostly by scientific peer review, [Marsh and Eros \(1999\)](#) investigated whether the community concerns about ethical issues associated with field research are addressed during the peer-review process by journals, many of which are administered by scientific societies. They examined the instructions to authors and reviewers of 141 journals from fields related to nature conservation, field biology including paleontology, natural resource management and bio-prospecting. Only one third of responding journals addressed ethical issues in their instructions to authors or reviewers. When ethical issues were considered, most of the journals limited their concerns to ethical issues associated with animal and human experimentation. No journal mentioned ethical practices in working with indigenous peoples or on traditional lands. Only two journals addressed the ethics of research in ecologically sensitive areas in their instructions to authors, only one in its instructions to reviewers. [Marsh and Eros \(1999\)](#) suggested that peer-reviewed journals should respond to emerging community concerns about the ethical issues associated with field research including working with indigenous peoples on traditional lands (and seas).

In preparing this essay, we again reviewed the instructions to authors and reviewers of 36 journals that accept papers on experimental marine biology and ecology to determine if they addressed ethical issues associated with field research as opposed to animal welfare issues. We also checked with editors by email. The editor of one journal that publishes articles on biological oceanography responded by asserting that the subject matter of papers published in that journal has 'nothing to do with animal/environmental ethics'.

Most (~ 56%) of the 36 journals we checked are silent on the issue. As outlined in the text table below, (25%) restrict their concern to animals, while small percentages address the impact of the research on endangered species or populations, or explicitly require that researchers adhere to the laws of the country in which the research was conducted. However, in our experience such laws (if they exist) are generally restricted to research on humans or sentient animals ([Table 1](#)).

Table 1

Coverage of ethical issues of field experimentation in instructions to authors and reviewers for 36 journals that accept papers on experimental marine biology and ecology

No mention	20
Animal welfare only	9
Impacts on endangered species or populations	2
Requirement to adhere to the laws of the country in which research is conducted	2
Requirement to minimize adverse consequences of the research	3
Total	36

In welcome contrast, the two journals we reviewed that are published by the Ecological Association of America (ESA) require authors to adhere to the ESA Code of Ethics which state ‘Ecologists will conduct their research so as to avoid or minimize adverse environmental effects of their presence and activities, and in compliance with legal requirements for protection of researchers, human subjects, or research organisms and systems’. In addition, the *Journal of Applied Ecology* draws authors’ attention to the Guidelines for the Use of Animals in Research published annually since 1991 by the journal *Animal Behaviour*: ‘Any possible adverse consequences of the work for ecosystem, populations or individual organisms must be weighed against the possible gains in knowledge and its practical applications’. Authors wishing to publish in *Journal of Applied Ecology* are also required to sign a declaration that their work conforms to the legal requirements in the country in which it is carried out (but see above).

In contrast to Marsh and Eros’ (1999) experience, four of the journals we contacted indicated that they would be interested in including information on ethical issues in their instructions to authors. We interpret this as a change in attitude since 1999 and we encourage the scientific community to support such initiatives. However, codes of conduct and guidelines developed by journals or scientific societies cannot ensure compliance with community expectations. Compliance will not always be evident from a manuscript submitted for publication after the research has been conducted. Neither will the methods section of a grant proposal. We conclude that self-regulation in the form of codes of conduct and guidelines needs to be developed in concert with external regulations to ensure that field experiments conform to community expectations. This would be a parallel development to the ethical guidelines and regulations that regulate research on sentient animals as a practical consequence of the animal welfare movement.

5. Aftermath of the controversy surrounding the Effects of Line Fishing experiment

As a result of the controversy surrounding the Effects of Line Fishing experiment and other field experiments in the Great Barrier Reef region, the question of environmental research ethics was referred to a working group of the Australian Science Technology and Engineering Council (ASTEC) which included two representatives of environmental management agencies; one representative of a conservation NGO; one person from an animal welfare NGO; five ecologists, one of whom is indigenous; two environmental

philosophers, and an independent, distinguished medical scientist as chair (who was amazed by the absence of guidelines). The 1997 Fenner Conference held under the aegis of the Australian Academy of Science focused on environmental research ethics (Kenchington and Lawrence, 1998), workshopping the draft documents developed by the ASTEC working group. The recommendations were subsequently finalized as an ASTEC report entitled ‘Environmental Research Ethics: National Principles and Guidelines for the Ethical conduct of Research in Protected and Environmentally Sensitive Areas’ (ASTEC, 1998).

ASTEC (1998) recommended that the ethical issues associated with environmental research should be incorporated in legislation to parallel legislation that addresses the ethical issues associated with research involving humans and sentient animals. This approach can, at best, be seen as a long-term solution and will not be an effective remedy to the immediate ethical challenges facing experimental marine biologists and ecologists. Although most field scientists apparently perceive no need to be proactive on this issue, our experience in the Great Barrier Reef region shows that the imperative can change rapidly in the face of public controversy.

The ASTEC report also recommended that management agencies use an Environmental Research Ethics Committee or similar arrangement as the deliberative process to advise them on the ethics issues raised by specific research proposals and provided generic guidelines for the establishment and operation of such committee. These guidelines can be customised to meet specialized needs. Not surprisingly given the history of controversies, the Great Barrier Reef Marine Park Authority (GBRMPA) had pre-empted this recommendation by establishing an interim research ethics committee in 1997. This committee was subsequently formally established and developed along the lines recommended by ASTEC (1998).

6. Guiding maxims

Animal ethics procedures have developed three guiding principles known as the three R’s: replacement, reduction and refinement (e.g., NHMRC, 1997). Following this approach, ASTEC (1998) recommended the Precautionary Principle² as the overriding principle within which field biologists should explore the potential for designing their research using four guiding maxims (the four M’s):

- *Movement* of the research, either away from an environmentally sensitive area, or to the use of less invasive techniques such as computer modeling
- *Minimisation* of procedures carried out, while ensuring the research has the required statistical power

¹ Having the capacity to perceive through the senses. Usually refers to a higher animal with the capacity to be aware of its environment on other than a purely chemical level, in a manner similar to human beings.

- *Modification* of experimental activities to reduce impact on the environment or the experimental biota
- *Maximising* the use and benefits of the research results.

We commend this approach.

7. Operations of the great barrier reef research ethics committee

The Great Barrier Reef Research Ethics Committee consists of five members chosen for their expertise as follows:

- A community specialist in heritage and conservation
- An expert in experimental design not involved in reef research, but with knowledge of marine ecosystems
- An ethicist/philosopher with expertise in the application of ethics relevant to natural resource management situations and environmental research
- A person reflecting the broad interests of the community in the Great Barrier Reef
- A senior officer of the Authority with knowledge of reef management, policy and procedures.

Although the Committee does not represent any particular group, it can receive advice through the appointed independent Chair. The Committee may also from time to time invite external experts to review aspects of matters where additional expertise may be required.

During its first 6 months the (interim) Great Barrier Reef Research Ethics Committee considered all permit applications and several previous applications that had raised ethical concerns (Hutchings and Kenchington, 1999). This led to the identification of a series of criteria for referral (Box 1). All of the ~ 200 applications for research permits considered each year are checked to determine if the research involves one or more of these triggers and now only the 1–2% which do are referred to the committee. Scientists have also become more aware of the ethical issues through the research permit application process (http://www.gbrmpa.gov.au/corp_site/permits/applications/research_permits/gbrmpa_res_permit_app.pdf). The application form explicitly asks how the potential impacts of the research have been reduced using the maxims outlined above (e.g., has the study been designed to minimize impacts, for example, by collecting the minimum number of individuals required?; can the research be done in a less sensitive area or on a less vulnerable species?; can alternative, less intrusive or less destructive techniques be employed?). Researchers are required to consider whether their research meets the criteria for referral listed in Box 1. In addition, researchers are actively encouraged to discuss ethical issues with GBRMPA staff when designing their research with a view to resolving potentially difficult issues. Institutional permits have been introduced for the major providers of research in the Great Barrier Reef Marine Park. This has increased institutional awareness of the ethical issues associated with field research.

As a result of these initiatives, the hype has gone out of the issue, most scientists have adapted painlessly to the new arrangements, and concerns about the future of experimental field research in the Park have largely evaporated. Nonetheless, some controversy remains. For example, an extensive project to map the seabed biodiversity throughout the 348,700 km² Great Barrier Reef World Heritage Area stalled for several years because of community concerns about the use of destructive techniques such as the use of a sledge and scientific trawling. The scientists considered that the ‘ratiogenic damage³’ was legitimate. Members of the NGO community disagreed. The project eventually went ahead with some compromises. The scientists were allowed to undertake scientific trawling without using the Turtle Excluder Devices (TEDS) or Biodiversity Reduction Devices (BRDs) that are mandatory for commercial fishers but agreed to: (1) use non-extractive sampling methods, such as towed and baited remote underwater videos at most sites, (2) limit destructive sampling to zones of relatively low protection, and (3) limit scientific trawls to 20 min to minimize the risk of killing turtles, and (4) not to use baited remote underwater videos in preservation (‘no-go’) areas.

Box 1. Criteria for referral of an application for a research permit to the Great Barrier Reef Research Ethics Committee

Research involves one or more of the following:

- An endangered, vulnerable or threatened species or population
- Introduction into the Great Barrier Reef Marine Park of animals, plants or other biological material
- Relocation or release within the Great Barrier Reef Marine Park of animals, plants or other biological materials to areas where they are not normally found
- Introduction or release of genetically modified animals, plants or other biological material
- Habitats of particular importance to the biology of endangered, vulnerable, threatened or commercially important species
- Involves the destruction/intrusion of the following nature: deliberate damage; taking of plants and animals; behavior manipulation/use of intrusive techniques. (At a significant scale in space/time and relative to the size of populations and habitats affected and ecological and geophysical process applying in the area)
- Use of toxic/radioactive/cumulative persistent chemicals
- Takes place in a preservation (‘no-entry’) zone
- May have a significant impact on uses(s) and value of the areas concerned and would require new or changed zoning provisions and regulations
- Is likely to be controversial or sensitive (culturally, socially) or seen to be cruel or to involve the infringement of privacy and property rights

³ Ratiogenic damage is ‘reason generated’ harm or damage; giving a greater value than is warranted or privileging a human activity such as scientific research, on the grounds that any damage done by the activity is warranted or legitimated by the knowledge gained see [ASTEC \(1998\)](#).

8. Ethical issues for experimental marine biologists and ecologists

To gain some appreciation of the likely incidence and nature of ethical issues in experimental marine biology and ecology, we reviewed the last 100 articles published in this journal following the example of Cuthill (1991) who conducted a similar exercise for an animal behavior journal. We identified 16 papers that might be referred to an ethics committee with criteria similar to that used by GBRMPA. We believe that this is a substantial overestimate of the number that would be referred in practice. Twelve papers were identified solely on the basis of the criterion ‘involving destruction/intrusion at a significant scale in space/time and relative to the size of populations and habitats affected and ecological and geophysical process applying in the area’. We could not judge the significance of the ‘damage’ caused by these research projects with the information provided but flagged them anyway. We anticipate that an environmental ethics committee would have considered the damage likely to be caused by most of these projects to be insignificant. Four papers were flagged because they involved threatened species or their habitats, and one involved the experimental introduction of a toxic chemical. One paper was flagged on the basis of more than one criterion. We conclude that in practice, the proportion of experimental marine biology and ecology projects that would be referred to an environmental ethics committee would be very low and the resultant administrative burden on scientists would also be low.

9. Where to from here?

In our experience, the personal costs to scientists resulting from controversies about research that the community considers to be ethically inappropriate can be devastating. Because it is impossible for scientists alone to judge community perceptions accurately, we urge experimental marine biologists and ecologists to take the following pre-emptive initiatives:

- encourage your institutional animal ethics committee to broaden its terms of reference to include environmental ethics with any required increases in the expertise of its membership;
- encourage relevant scientific societies to develop an appropriate code of ethics to guide the environmental research conducted by their members;
- encourage relevant editorial boards of journals to require that the research they publish conform to an appropriate code of ethics;
- encourage management agencies that issue permits for field research to establish a Environmental Research Ethics Committee or similar arrangement to advise them on the ethics issues raised by specific research proposals.

We urge experimental field ecologists to observe high standards of research ethics irrespective of where they are conducting their fieldwork. To take advantage of a lack of regulations in a developing country seems the worst kind of scientific hubris.

Acknowledgements

Our thanks to colleagues for many stimulating discussions on ethical issues, Jeanine Almany for reading and classifying the last 100 papers in JEMBE and for invaluable research assistance, and to the editors of JEMBE for their invitation to write this essay. [S.S.]

References

- ASTEC, R., 1998. Environmental research ethics: National principles and guidelines for the ethical conduct of research in protected and environmentally sensitive areas. ASTEC, Canberra.
- Beale, R., 1998. Manipulative research in environmentally sensitive areas: its influence on government decisions, and the importance of ethical practice. *The Ethics of Environmental Research: Proceedings of the 1997 Fenner Conference*. *Aust. J. Environ. Manag.*, vol. 5, pp. 46–49.
- Commonwealth of Australia Gazette, 1996. Government Notice Number 50.
- Cuthill, I., 1991. Field experiments and animal behaviour: methods and ethics. *Anim. Behav.* 32, 1007–1014.
- Farnsworth, E.J., Rosovsky, J., 1993. The ethics of ecological field experimentation. *Conserv. Biol.* 7 (3), 463–472.
- Hutchings, P., Kenchington, R., 1999. The ethics of research in protected and other environmentally sensitive areas. *Mar. Pollut. Bull.* 38 (6), 429–430.
- Kelleher, G., Bleakley, C., Wells, S. (Eds.), 1995. *A Global Representative System of Marine Protected Areas, GBRMPA*. The World Bank and IUCN, Washington, DC. 4v.
- Kenchington, R., 1990. *Managing Marine Environments*. Taylor and Francis, New York.
- Kenchington, R.A., Lawrence, D. (Eds.), 1998. *The Ethics of Environmental Research: Proceedings of the 1997 Fenner Conference*. *Aust. J. Environ. Manag.*, vol. 5. Special Supplement.
- Lawrence, D., Kenchington, R., Woodley, S., 2002. *The Great Barrier Reef: Finding the Right Balance*. Melbourne University Press, Victoria.
- Mapstone, B.D., Campbell, R.A., Smith, A.D.M., Cooperative Research Centre for Ecologically Sustainable Development of the Great Barrier Reef (Australia), 1996. Design of experimental investigations of the effects of line and spear fishing on the Great Barrier Reef. CRC Reef Research Centre, James Cook University, Townsville, Qld.
- Marsh, H.D., Eros, C.M., 1999. Ethics of field research: Do journals set the standard? *Sci. Eng. Ethics* 5, 375–382.
- NHMRC, 1997. *Australian code of practice for the care and use of animals for scientific purposes*. Australian National Health and Medical Research Council, 82 pp.
- Walters, C.J., Green, R., 1997. Valuation of Experimental Management Options for Ecological Systems—Invited Paper. *J. Wildl. Manage.* 61, 987–1006.