The Role of Field Stations in the Preservation of Biological Diversity

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Field stations should assume a more active role in the preservation of species diversity and intraspecific genetic variation. Because some field stations concentrate scientists in remote places far from major universities, they are often the only source of biological expertise in the area. Others, located in more densely populated regions, may contain the last surviving remnants of natural ecosystems there. Field stations should locate and identify local populations of rare or endangered species and take the necessary steps for their preservation, begin long-term research on the population biology of these species, and offer conservation-oriented courses to students and the general public. (Accepted for publication 23 February 1982)

It is predicted that within the next 20 years hundreds of thousands of species of plants and animals will become extinct (Council on Environmental Quality 1980, Ehrlich et al. 1977). Countless others will have their ranges so contracted or fragmented that they will become likely candidates for extinction soon thereafter (Soulé and Wilcox 1980). If this trend is to be reversed, and it is critically important for the long-term survival of mankind that it be reversed, a massive conservation effort must be mounted during this decade.

Conservation biologists are generally united in the belief that the only truly effective way to preserve the world's biological diversity (used here in its broadest sense of both species diversity and intraspecific genetic variation) is to set aside large blocks of habitat (e.g., Frankel and Soulé 1981, chapter 5). Establishing a worldwide network of large, unmanaged reserves will not only help to minimize extinction probabilities for many rare species, but habitat preservation per se is also extremely desirable. The world needs large blocks of undisturbed habitats operating as natural ecosystems for the "public service" functions they provide (c.f., Ehrlich and Ehrlich 1981, Westman 1977).

Most of the world's biological diversity is in the tropics, and tropical ecosystems, especially the moist forests, are currently the most threatened (Myers 1980, US Department of State 1978). Conserving these resources is going to be enormously difficult and challenging since many tropical countries are economically undeveloped, some are politically unstable, and a few are suspicious, if not openly hostile, toward conservation efforts, especially those perceived as coming from the developed world. What role, then, will temperate zone biologists play in the conservation of biological diversity in the near future? Will they continue to be "preoccupied with fighting rear-guard actions around a few prominent endangered species and populations in their countries while Earth's main treasure-house of diversity is being looted wholesale" (Ehrlich and Ehrlich 1981, p. 140–141), or will they continue to play an active role in world conservation efforts?

I think that the latter is far more likely to occur. To begin with, many of these countries, especially the United States, Sweden, and the United Kingdom, are generally acknowledged as world leaders in conservation. Less developed countries will continue to utilize scientific manpower and expertise from these nations for the indefinite future. Second, the temperate zones have no shortage or rare or endangered species themselves, although the absolute number may be small compared to the tropics. Finally, relatively large numbers of temperate zone biologists utilize field stations in their teaching and research. It is my contention that these field stations represent natural foci for teaching and research in biological conservation, and that these institutions must now take an even more active and vigorous role in conservation activities than they have in the past. Such activities include locating populations of rare and endemic species and taking steps to ensure their protection, initiating long-term research on the population biology of these species, and, perhaps most importantly, educating students and the general public on the importance of preserving biological diversity.

Field stations, which I will broadly define as any facility or tract of land used primarily for biological research or teaching and which is maintained in a natural or seminatural state, are especially well suited to these activities. If they are located in remote areas, far from major universities, they attract many professional biologists to these regions who would not be attracted there otherwise. If they are close to densely populated areas they may represent the last remnant of natural habitat in the region.

The Rocky Mountain Biological Laboratory (RMBL) is an independent field station located at Gothic, Colorado, near

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[1]Dr. William K. Baker, University of Utah and Rocky Mountain Biological Laboratory, personal communication, January 1982.

the town of Crested Butte. I will use RMBL as an example throughout this paper, not only because I am more familiar with it than I am with other similar institutions, but also because it should be fairly typical of field stations in the United States and other developed nations.

EXPLORATION

One of the most important roles that field stations can fulfill in the preservation of genetic diversity is locating and identifying populations of rare species in their local areas. Many such populations have been discovered by field station biologists in the normal course of their teaching and research activities. *Drosophila novitskii*, for example, is currently known only from a few specimens collected in the East River Valley in Colorado (W. K. Baker[1], Sulerud and Miller, 1966). Although it may occur elsewhere, its existence may never have been discovered if RMBL scientists had not been actively studying other *Drosophila* species.

There are several kinds of rare species. Drury (1974) has developed ideas on rarity in detail, and I will use his general classification scheme here (although many intermediate situations obviously exist). One kind of rarity includes organisms that are restricted to one or a very few areas—local endemics. Although these species may have quite small ranges, they may occur in large numbers within these ranges. The rockcress *Arabis gunnisoniana* is an example of this type; although this plant has never been collected outside of Gunnison County in Colorado, it is quite abundant there (Barrell 1969). A second type of rarity includes those species that are found in very small numbers in any given area, but occur in many suitable habitats over a wide range. Drury (1974) suggests that certain raptorial birds fit this model. The third, and perhaps most common, type of rarity includes those species that occur in small, widely separated populations. These may be relict species that were formerly more widespread, but whose ranges have been fragmented by climatic changes or habitat alteration related to human activities, or they may be species that have never been abundant or widespread. Many examples of both come to mind; Drury (1974) cites several (e.g., Bachman's Warbler, *Vermivora bachmanii*).

In their recent report, Willey and Willey (1976) document the existence of 70 rare or endemic species of plants and animals in the RMBL area: 3 mammals, 11 birds, 1 amphibian, 3 insects, 6 ferns, and 46 higher plants. Some of these are relict populations of more northern species left behind after the retreat of the most recent glaciation; a few are species endemic to the local area. However, there is no reason to suspect that the region around RMBL is particularly rich in rare species. The large number of rare plants and animals known from there is almost certainly directly correlated with the amount of biological exploration that has gone on in the 54 years since its founding. If they have not already done so, all field stations should make special efforts to locate such populations and take steps to insure their continued existence.

PRESERVATION

The primary function of most field stations is teaching, research, or some combination thereof, and it may be politically inexpedient for them to confront mining, lumbering, or other development interests on conservation issues directly unless their own operations are clearly threatened by such activities. Fortunately, however, field stations usually attract many conservation-oriented individuals who are often willing to devote, as private citizens, the time and energy necessary to establish natural areas and preserves and to protect endangered species or unique local populations. Such protection can be achieved in a number of ways. For example, RMBL's 205 acres of land at Gothic, plus a 40 acre holding elsewhere, both function as small nature preserves. However, the acreage under its protection is increased considerably by several US Forest Service special use permit areas, by the nearby 1050 acre Gothic Natural Area established by the USFS in 1928, and by the 450 acre Mexican Cut Research Preserve purchased by the Nature Conservancy in 1965 and administered by RMBL. Much of the effort to secure Mexican Cut did not come directly from the laboratory administration, but rather from the tireless efforts of a few RMBL scientists acting of their own volition.

Furthermore, several RMBL scientists played an important role in the development of the Forest Service's East River Plan, a document that established the laboratory's claim to undisturbed habitat as a natural resource. This is one of the first environmental impact statements that recognizes research and education as a valid part of the multiple use of public lands. This concept was so novel that one of the mining companies active in the area was moved to complain that RMBL was "taking irresponsible advantage of all legal means to preserve the habitat up there."[2]

There have been failures as well as successes. A small population of the water spring beauty, *Montia chamissoi*, was inadvertently destroyed by road construction for a nearby ski area. This was the only known population in Gunnison County (Barrell 1969). A unique, disjunct habitat known as the Iron Bog, which supports several relict populations of plants and insects, will almost certainly be lost to mining development in the next few years, despite the apparent willingness of the mining company (AMAX Corporation) to take any steps short of stopping their operation to prevent it. Likewise, relict populations of *Leucorrhinia hudsonica*, a dragonfly known in Colorado only from a small hanging cirque called Peeler Basin, are threatened by mining activities sanctioned by the Mining Law of 1872, a law that gives priority to mineral development over all other multiple uses of public land. Although RMBL has decided that it is not in its own best interest to take stands on some of these issues, its administration consistently encourages conservation-oriented scientists at the laboratory to do so as concerned citizens.

RESEARCH

Since most ecologists have concentrated on studying abundant organisms, we know relatively little about the population biology of rare species. As Miller and Botkin (1974) have pointed out, many endangered species are so close to extinction that the time for serious scientific study is past; only political action can save them. For other species and for many genetically unique local populations, however, extinction is a more distant prospect, and there is still time for research that will tell us more about their ecological requirements and the ways in which we might manage them in order to prevent their demise.

Rare species that occur in small, widely scattered populations may well be the most amenable and important to study. This type of population structure can be extremely hazardous for long-term survival for two reasons. First, stochastic

[2]Dr. Ruth L. Willey, University of Illinois, Chicago Circle and Rocky Mountain Biological Laboratory, personal communication, August 1981.

numerical fluctuations in small populations inevitably result in the eventual extinction of that population; second, low effective population sizes (N_e's) in small populations eventually lead to a loss of long-term fitness and evolutionary potential through inbreeding and genetic drift. Frankel and Soulé (1981) estimate that a minimum N_e of 50 is necessary even for short-term survival of a population; long-term survival requires a minimum N_e of 500. However, examples are known of populations that have evidently persisted for hundreds or even thousands of years with N_e's almost certainly smaller than 500 (e.g., populations of pupfish and minnows isolated in remnant springs of the Great Basin since the drying-up of Pluvial lakes some 8–10,000 years ago). It may well be that these populations have little long-term potential for survival into the indefinite future. However, they still must be preserved for both moral and aesthetic reasons, even if their existence beyond the next few hundred years or so is in doubt, and learning as much as possible about these unique populations will yield important insights into the biology of rare species in general.

Local endemics, even if abundant, are clearly interesting objects of study in their own right. Furthermore, one need only to recall the story of South Africa's golden gladiolus (Ehrlich and Ehrlich 1981, p. 135) to be reminded of how fast a formerly abundant local species can disappear as a result of a variety of anthropogenic pressures. Widely distributed but sparse species present special problems; they are hard to study, and their populations often transcend several political or administrative boundaries. Despite these difficulties, I would hope that field station investigators would begin to undertake more research on species with these characteristics.

Thus, I suggest that populations of rare plant and animal species should become the focus of considerable research effort. Such research will not only contribute greatly to our understanding of the ecology and evolutionary biology of rare species, but it will also provide important insights into conservation strategies. Again I emphasize that field stations are uniquely suited to initiate and carry out such projects. Once suitable populations have been located, long-term studies on their demography, breeding structure, and ecology should be initiated. Needless to say, these studies must be based on both a comprehensive understanding of the life system of the population (Clark et al. 1978) and on its evolutionary history (Harris and Williams 1975).

Possible support for such a research program could be obtained from the recently established Long-Term Ecological Research (LTER) Program of the National Science Foundation. Under this program, both selected field stations and individual investigators can obtain support for long-term studies. These studies, especially of rare organisms, are badly needed.

EDUCATION

Finally, one of the most important roles that field stations can play in the preservation of genetic diversity is education. Courses in field ecology are especially critical for instilling in students an awareness of their own dependence on natural ecosystems for numerous essentials of everyday life. Many field stations also offer graduate and undergraduate courses that are not available at many students' home institutions; mammalogy, ornithology, and field botany courses disappeared long ago from many departments' curricula. Courses such as these, when properly taught in a field setting, not only serve to acquaint students with the natural history and general biology of some taxonomic group, but also instill in the students an appreciation of whole organisms and, hopefully, some sympathy for their conservation.

In addition to insuring that the "ologies" continue to be taught, field stations would do well to expand some of their course offerings to reach more of the general public. As Westman (1977) aptly points out, "It is essential for the public to have a clear idea of the benefits they obtain from nature in its undeveloped state." Short courses on aspects of the local flora or fauna or on the general ecology of the area, lasting a day or a weekend, can be enormously successful. For example, a program called "Bioquest" has been offered to local residents by RMBL for the last several years. Given on a Saturday or Sunday, Bioquest offers short lectures, displays, and nature walks; topics have included mammals, birds, wildflowers, and Rocky Mountain ecology. Including lunch and two coffee and donut breaks, the cost in 1981 was a nominal $12, and over 30 persons attended. A similar offering covering the rare and endangered species present in some local area could prove to be a very effective consciousness-raising effort for the citizenry; people seem to be very impressed when they are made aware that something unique can be found in their own back yards.

Field stations must also begin to offer rigorous courses in conservation biology. Such courses should include lectures on the process of extinction, species-area relationships and the design of nature preserves, genetic aspects of conservation, the management of endangered species, and the principles of captive propagation. Suitable texts and other readings might include Ehrenfeld (1970), Duffey and Watt (1971), Myers (1979), Soulé and Wilcox (1980), Ehrlich and Ehrlich (1981), and Frankel and Soulé (1981) among others. A field setting would be ideal for a course like this, since students could have the opportunity to get hands-on experience manipulating selected populations of unendangered species as well as observing some rare or endangered ones. RMBL will be offering such a conservation biology course in the summer of 1982.

ACKNOWLEDGMENTS

I thank Thomas Eisner, Pamela Parker, Michael Soulé, and Ward Watt for several stimulating discussions on the general topics covered in this paper as well as for reading and commenting on the manuscript. Robert and Ruth Willey furnished me with much background information concerning RMBL's efforts in local conservation.

REFERENCES CITED

Barrell, J. 1969. *Flora of the Gunnison Basin*. The Natural Land Institute, Rockford, IL.

Clark, L. R., R. L. Kitching, and P. W. Geier 1978. On the Scope and Value of Ecology. *Protection Ecology* 1: 223–243.

Council on Environmental Quality 1980. *Biological Diversity*. US Government Printing Office, Washington, DC.

Drury, W. H. 1974. Rare species. *Biol. Conserv.* 6: 162–169.

Duffey, E., and A. S. Watt, eds. 1971. *The Scientific Management of Animal and Plant Communities for Conservation*, Blackwell Scientific Publications Ltd., London.

Ehrlich, P. R. and A. H. Ehrlich 1981. *Extinction*. Random House, New York.

Ehrlich, P. R., A. H. Ehrlich, and J. P. Holdren 1977. *Ecoscience: Population, Resources, Environment*. W. H. Freeman, San Francisco.

Ehrenfield, D. W. 1970. *Biological Conservation*. Holt, Rinehart, and Winston, New York.

Frankel, O. H. and M. E. Soulé 1981. *Conservation and Evolution*. Cambridge University Press, London.

Harris, J. A. and D. G. Williams 1975. The ecological basis for natural resource management. Pages 192–203 in Kikkawa, J. and H. A. Nix, eds. Managing Terrestrial Ecosystems. *Proc. Ecol. Soc. Aust.* 9.

Miller, R. S. and D. B. Botkin 1974. Endangered Species: Models and Predictions. *Am. Sci.* 62: 172–181.

Myers, N. 1979. *The Sinking Ark*. Pergamon Press, Oxford.

______. 1980. *Conversion of Tropical Moist Forests*. National Research Council, National Academy of Sciences, Washington, DC.

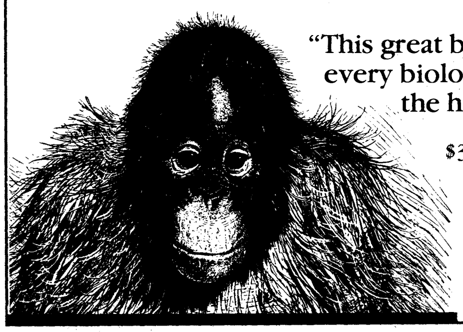
Soulé, M. E. and B. A. Wilcox, eds. 1980. *Conservation Biology*, Sinauer Associates, Sunderland, MA.

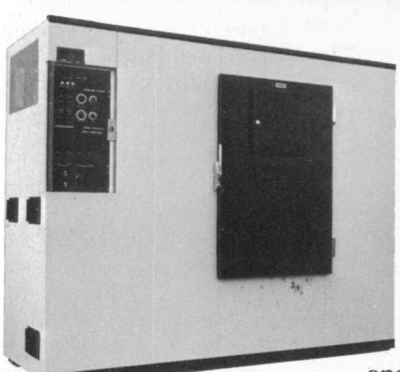
Sulerud, R. L. and D. D. Miller 1966. A study of key characteristics for distinguishing several *Drosophila affinis* subgroup species, with a description of a new related species. *Amer. Midl. Nat.* 75: 446–474.

US Department of State 1978. Proceedings of the US Strategy Conference on Tropical Deforestation. Washington, DC.

Westman, W. E. 1977. How much are nature's services worth? *Science* 197: 960–964.

Willey, R. B. and R. L. Willey 1976. *Biologically Significant Areas in Gunnison County, Colorado*. Rocky Mountain Biological Laboratory, Crested Butte, CO.





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