What Good Is Ecology?

by Robert F. Inger

Persons like myself who have been doing research in ecology for years are often frightened, as members of the human race, and disappointed, as professionals, that society is not using what is now known of that branch of science. Few of us think it appropriate or desirable that ecologists alone make decisions about matters in which all citizens should share some responsibility. But society ought to use and apply ecology in appropriate situations, just as it applies the knowledge of other sciences in various technologies. The following examples may serve to illustrate what I mean by "using" ecology:

Pesticides

Since the appearance of Rachel Carson's *Silent Spring* in 1962, the use of pesticides to control harmful or nuisance insects has probably generated more heated public debate between ecologists and government agencies than any other "environmental" problem. Ecologists have regarded the advocates of broadcast use of nonspecific pesticides as just plain ignorant. When a particular insect begins to inflict measurable damage on a crop, we have usually initiated an ambitious program of spraying a general pesticide over a large area. Such programs almost always fail and almost always create new problems; and these negative results usually develop rather rapidly.

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What makes ecologists hopping mad is that we (the technologically advanced societies) have known enough about ecology to predict these failures in advance. Specifically, the relationships that have been understood for years are:

- General pesticides affect a large array of species, even an entire animal community.
- Smaller living things, such as insects, are affected more radically and more rapidly by pesticides than are larger animals.
- The reproductive rate of herbivores, or plant-feeders (whether leaf-eating insects or grass-eating mammals), is greater than that of their predators.
- Populations of herbivorous animals are kept in check by predators.
- The principal predators of insects are other insects.
- The most important herbivores in the world, in terms of total vegetation consumed, are insects.
- Most herbivorous insects are not pests, partly because they are kept in check by other insects that prey on them.

So we spray a general poison over a large area, thus killing large numbers of insects, many of them members of the target species (the pest), many of them the normal predators of the pest, and many of them non-pests, though herbivorous. All of these populations are depressed, but none are exterminated.

If we now reduce the level of spraying, all these populations begin to rebound, but not at the same rate. The herbivorous insects rebound faster than their normal predators because of their higher reproductive rates. Not only is this true of our target pest; it is equally true of the non-pest herbivorous

Spraying crops with DDT in this manner was a common sight until it was recognized that the insecticide posed a threat to wildlife and, ultimately, to man.

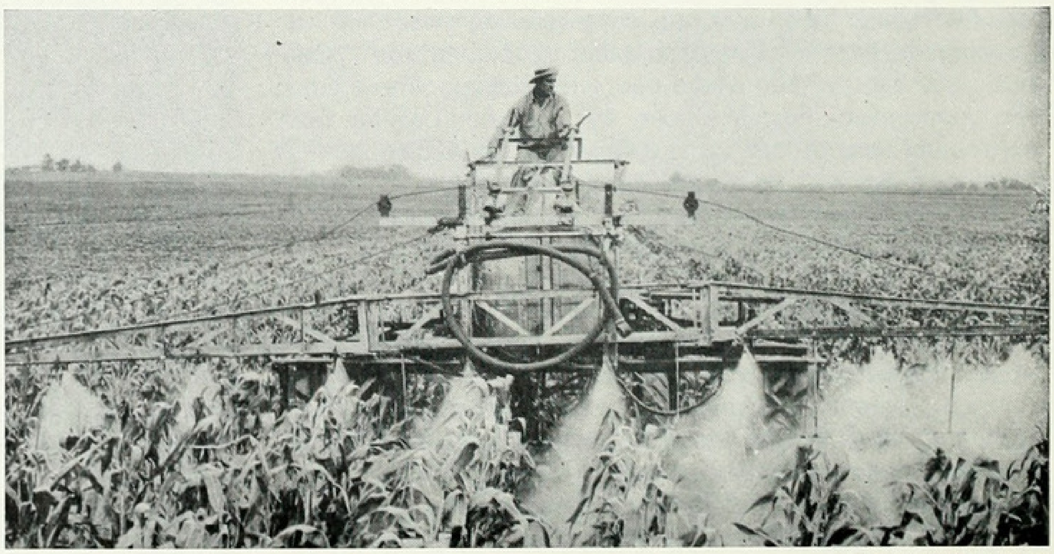
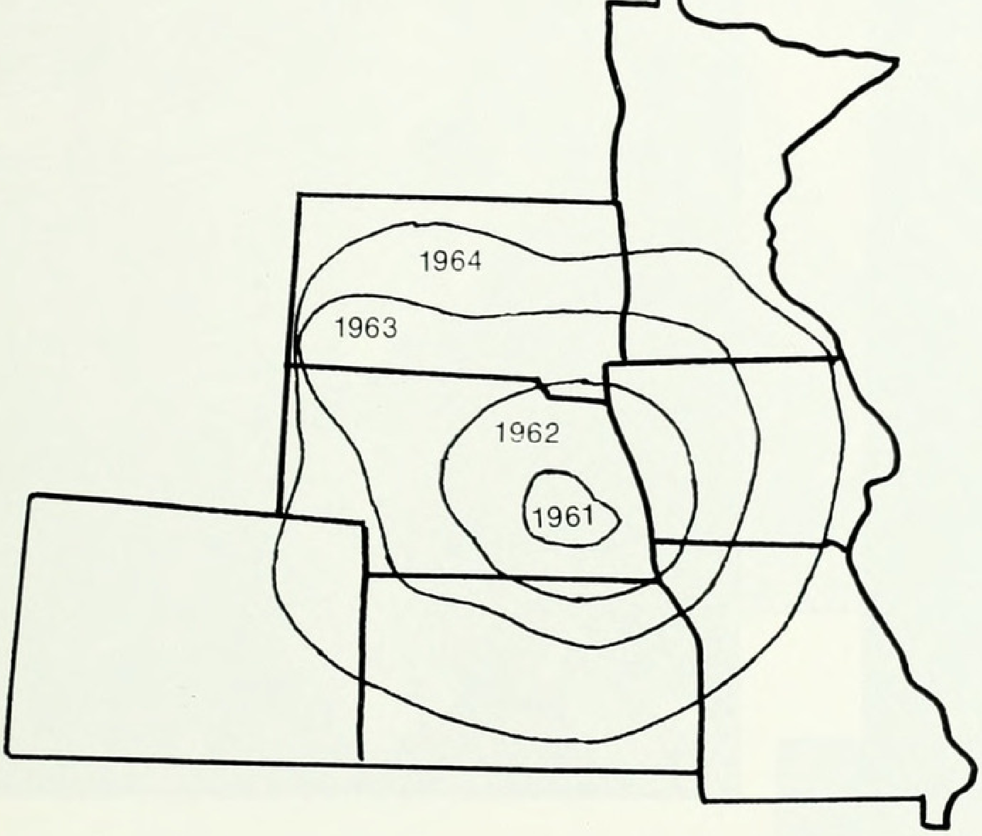


Photo by UPI Compix



In three years a population of the highly destructive western corn rootworm that was resistant to dieldrin and related insecticides spread from a few counties in western Nebraska to an area that included sections of seven midwestern states. The extent to which the population spread at one-year intervals is shown above.

insects, some of which may develop such large populations under these circumstances that they become pests.

So instead of having just one pest to contend with, we now have many, because inadvertently, but *predictably,* we have disturbed the populations that had formerly kept some of these plant-eaters under control.

Or we could continue spraying indefinitely. But not only is such a procedure costly and perhaps directly dangerous to human health; in the end it is doomed because continued mass spraying almost invariably is followed by insect pests developing immunity to the poison. This has occurred with 129 important agricultural pests, including the western corn rootworm. Resistance has also developed in medically important insects, such as 21 species of *Anopheles,* the malaria-transmitting mosquitoes.

The failure of mass spraying of pesticides to control agricultural pests does not mean we should discontinue the fight and let these pests take over. There are many examples of successful programs that are ecologically safe and sound and economically practical. They include the use of natural predators and parasites, chemical lures (mainly sex attractants affecting single species), mass release of sterilized males, and the spot application of poison at critical points in the life cycle of the pests.

Wonder crops and the green revolution

"Wonder crops," like pesticides, have not lived up to all expectations. And

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29th Chicago International Exhibition of Nature Photography

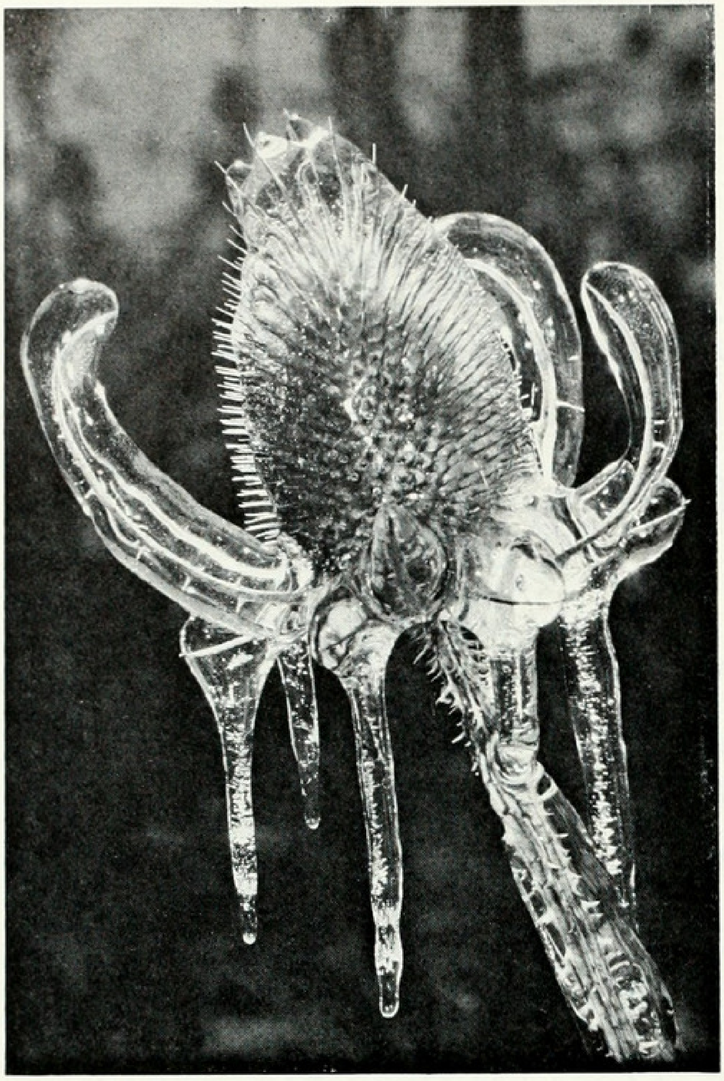
This year's Chicago International Exhibition of Nature Photography, sponsored jointly by Field Museum and the Nature Camera Club of Chicago, was truly an international affair. More than 700 amateur photographers from all over the world entered the competition; each of the continents and many foreign countries were represented.

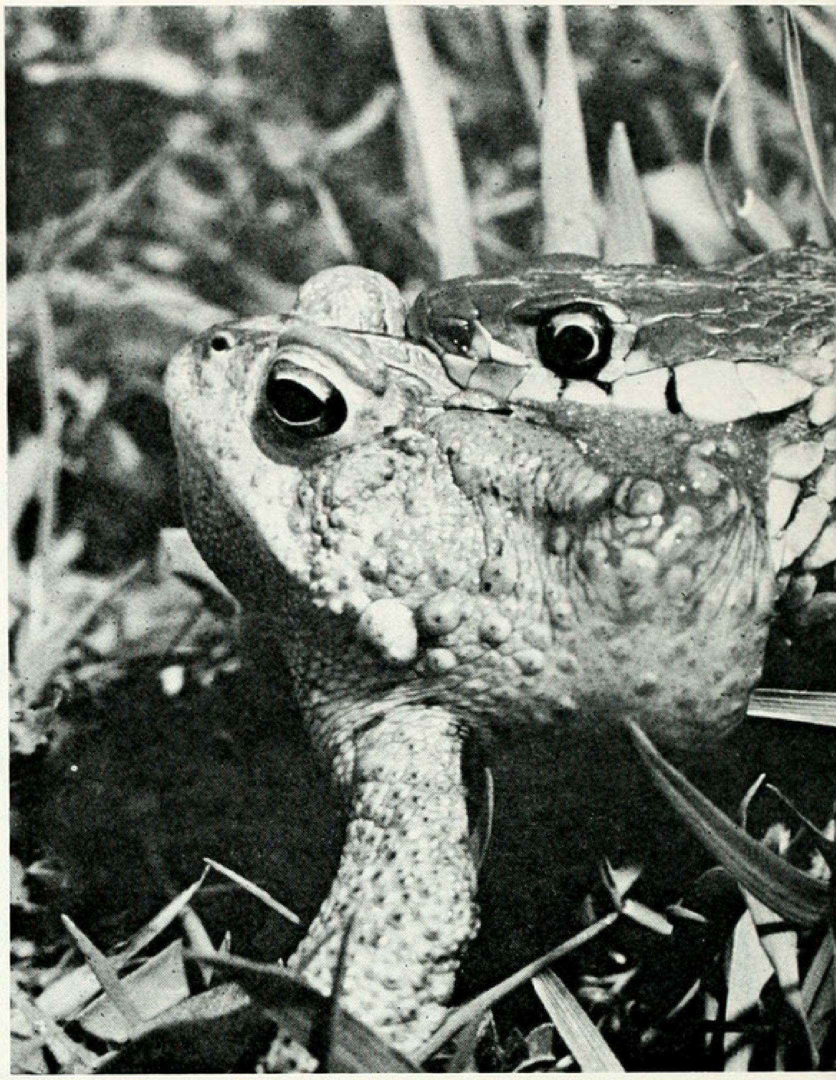
In excess of 3,000 color slides were entered; 700 were selected by the judges for public showing in February at the Museum. These photos represent some of the best nature photography being done in the world today —largely by amateurs who pursue this interest only as a hobby.

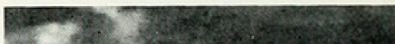
During the nearly three decades that these exhibitions have been held, two distinct trends have occurred: The first is in an improved image quality made possible by better film, cameras, optics, and flash equipment. The second change is that of an expanding geographic scope. This year more photos of the Antarctic region were entered than ever before. There was also more underwater camera work done in tropical seas. These photographers have not only been stimulated to examine the world about them more thoroughly, their interest has led them to the far corners of the earth.

—William Burger
President, Nature Camera Club of Chicago

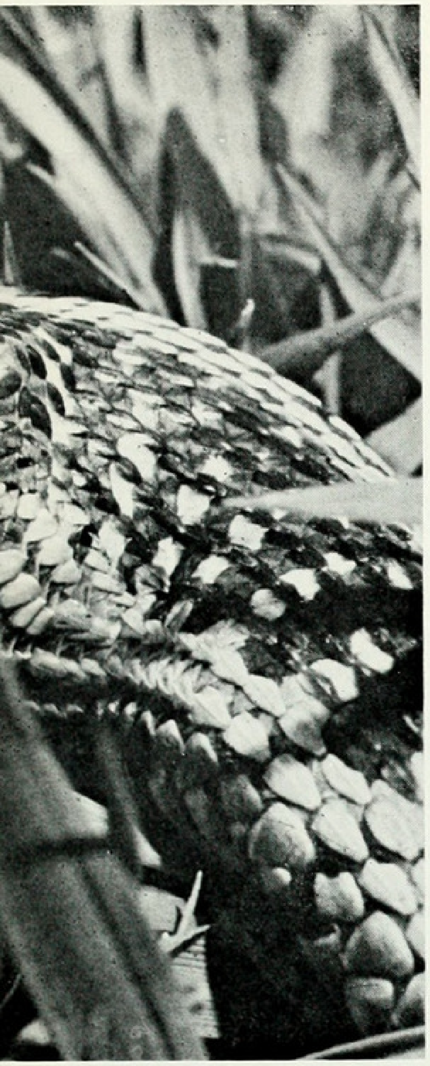
The six photos on pages 8-9 (as well as the cover photo) were among those awarded "Honorable Mention" by the exhibition judges. Top left: "Ice-clad Teasel," by Thomas Yoshida, Hamilton, Ontario, Canada; top center: "Survival of the Fittest," by Don Wollander, Cedar Springs, Mich.; top right: "Fox Number Three," by Lawrence J. Smith, Santa Barbara, Calif.; bottom left: "Haleakala Crater," by Hank Greenhood, San Jose, Calif.; bottom center: "Patient Fisherman," by Marie R. Kirkland, Bountiful, Utah; bottom left: "Drenched Anemones," by Eva C. Keller, Colorado Springs, Colo.

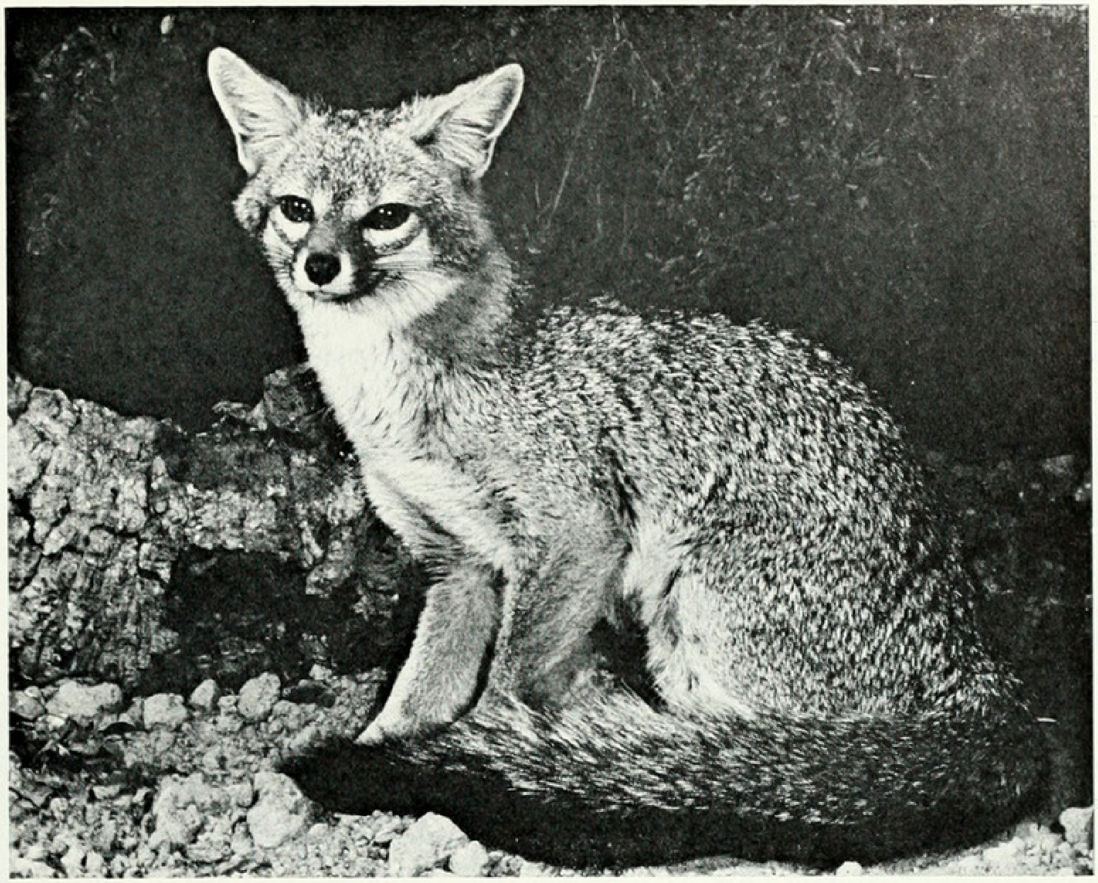


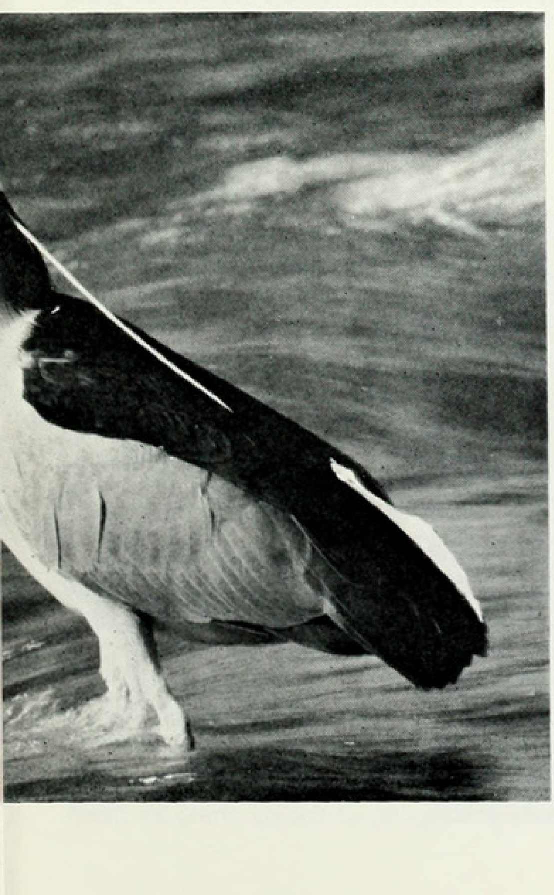




For captions see p. 9







ECOLOGY *(from p. 9)*
that failure is the result of having expectations divorced from ecological reality.

Application of the science of genetics to the growing of food plants has been gradual. Suddenly we realized that the green revolution was upon us: miracle wheat, hybrid corn, wonder rice. The food problems of the world could be solved through plant genetics and massive use of chemical fertilizers. Maybe. But there are these ecological phenomena to be considered:

- Species and varieties of plants vary in their rates of production.
- The productivity of a given species or variety of plant is not constant but varies depending upon environmental factors such as rainfall, temperature, etc.
- Most plant species, including all major food crops, are subject to a number of diseases, mainly caused by viruses and fungi that are highly specific in terms of the plants they attack.
- Simple ecosystems—those composed of one or very few species or varieties are less stable than diverse ones.

Another kind of biology—evolutionary biology—which is difficult to separate from ecology, has an important concept to contribute here: All species of plants and animals mutate; all are subject to spontaneous genetic changes whose occurrence and effects are unpredictable.

So we develop a highly productive, genetically homogeneous strain of corn or rice and cultivate it over vast areas in order to satisfy the nutritional needs of man's increasing population. All will go well, assuming we can produce and distribute enough fertilizer, unless or until a drought occurs. But since all the wonder grains require large amounts of water compared to their less productive relatives, they are more seriously affected by drought. The regions where most grains grow—the temperate and subtropical areas—are subject to drought. We can safely predict that any large grain-growing area will experience a severe drought, though we cannot with our present technology predict when it will occur. And if that area has been planted to a wonder grain, its harvest is almost sure to be smaller than if it had been planted with the old, genetically heterogeneous varieties.

The other hazard to which the green revolution is exposed is plant disease. When a large area is sown in a single crop—particularly a genetically pure strain such as a wonder grain—a virus or fungus disease can spread with great speed and cause extensive loss. In a recent growing season, corn leaf blight spread from the Gulf of Mexico to the Great Lakes and reduced the corn crop of that region about 25 percent. Plant geneticists respond to such a situation by developing a variety with resistance to the particular disease. They succeed, but only for a while. For here's where evolution steps in: Plant viruses and fungi mutate and in time a new strain of fungus or virus will develop the capacity to overcome the supposed genetic resistance of the crop. We can't say when this will happen, we only know that ultimately it will.

Should we then abandon all hope of increasing food production by this means? My answer as a citizen, not as an ecologist, is *no*. But as an ecologist, I feel constrained to say that there is nothing magical about the green revolution. It offers no hope of avoiding periodic, severe hunger. There are ways, however, to minimize some of the hazards, the main one being to avoid planting large areas with a single strain or species of food crop. Diversity of planting can buffer the total crop against loss by either drought or disease.

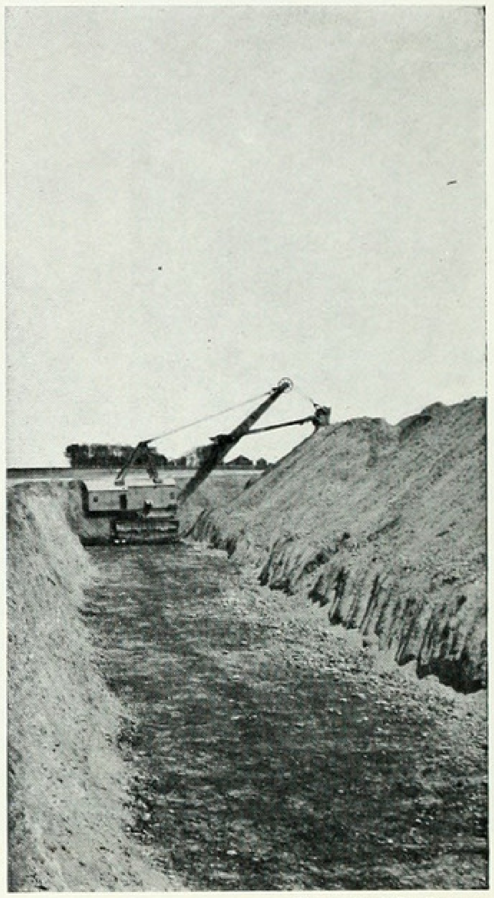


Photo by UPI Compix

In North Dakota a huge stripping shovel removes rich topsoil in order to reach low-grade coal 40 feet below the surface.

Mining and biological succession

Now for an example in which ecological concepts are important but not dominant. Our search for fuel sources has pushed us in the direction of extracting oil shales and strip-mining coal in the West. Because much of the oil shales are on public lands, the federal government has developed conditions for leases by private industry. So far only six prototype leases, each covering about 5,000 acres, are at issue.

The oil-extraction process will disturb the land severely and inevitably destroy existing vegetation cover. To cope with this environmental destruction, the federal leases call for restoration of the vegetation so that the same number and the same species of animals will occur following the mining and processing of the oil shale as did before. This is a noble objective, but unfortunately it is ecological hogwash.

There is an ecological phenomenon called succession, a process that can be observed everywhere in the world. Abandon a cornfield in Illinois and what happens? Annual weeds move in first, are gradually displaced by perennials and shrubs and small trees (hawthorn and crab apple), and in turn are displaced by larger, longer-lived trees until the climax, or steady-state assemblage, is reached. Barring disturbance, this steady-state will last for thousands of years. Disturb the soil severely at any point in this process of succession and the system reverts to annual weeds.

The animals, being completely dependent on the plants, pass through succession stages in parallel with the plants. Disturb the soil, and the animals as well as the plants revert to an early stage of succession.

Hardly any action by man disturbs vegetation more profoundly than what will occur as the result of extracting oil shale. To believe we can wave a federal lease in the air and command plants and their associated animals to forego the responses they have evolved over millions of years—that strikes me as helplessly ignorant or arrogant.

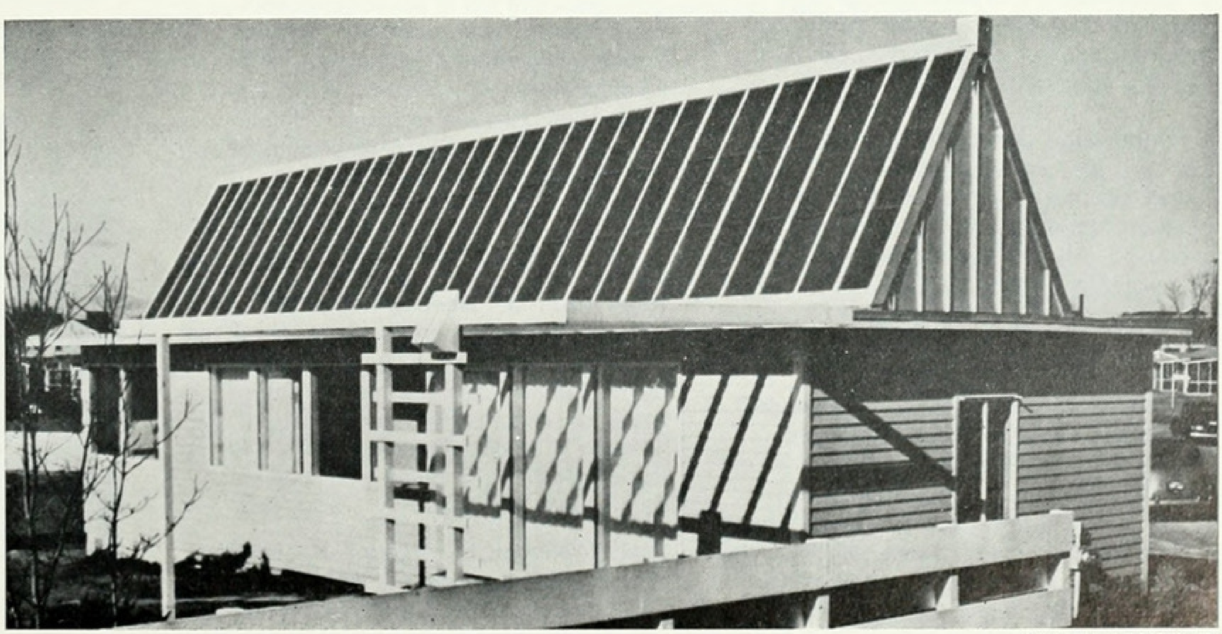
Processing oil shales requires large amounts of water, produces large amounts of saline waste water, and seriously affects air quality. All of these are environmental problems every citizen should consider. But these problems are not in the province of ecology. Rather, they are the professional concerns of other environmental scientists—geologists, hydrologists, and atmospheric scientists. I do not know what scientists in those fields think about the environmental problems associated with processing oil shale. From the ecological point of view, however, the terms of the leases cannot be carried out.

Solar radiant energy

One final example—conversion of solar radiant energy into other forms of energy. Somewhere—an unkown distance into the future—lies the application of this only real "income" the earth has.

One of the major advantages of converting solar energy for human use is that there are none of the pollutants such as sulfur dioxide, nitrogen oxides, particulates, or radioactive wastes that result from the use of fossil or nuclear fuels. The major possible hazards associated with solar energy conversion is the buildup of waste heat and warming of the earth's atmosphere. (These same hazards are also consequences of our present energy technologies.) A highly significant environmental issue, though one that will not affect us for some time to come, is posed here. But we will get no help from ecology, because the major questions involve rates of heat dissipation of various wavelengths—a problem that is mainly the province of atmospheric physics.

Finally, let me answer the question posed by the title of this article. Ecology does not differ from any other science in terms of its value to mankind. Ecology, as any science, is a body of knowledge, a mass of data and concepts, even a set of natural laws; and it is only one of the environmental sciences. But it is not a complete body of knowledge—there is much we still do not understand. Ecology is not magic; it is not the key to a rosy, untroubled future. On the other hand, unless we use this body of information and those of other environmental sciences, we will find ourselves as impotent as old King Canute commanding the tide not to come in.



The use of solar radiant energy for heating the home is nothing new. In 1949 this experimental "solar" house was built by Massachusetts Institute of Technology engineers in Cambridge, Mass. Solar energy is collected by panels on the roof.

Photo by UPI Complx