NORTHWEST AREA FOUNDATION newsletter

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Cedar Creek Revisited

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"Technological advances resulting from research and development or applied research are dependent on a well filled 'storehouse of knowledge' made readily available through scholarly publications. We depend on basic research to keep the 'storehouse' filled.

"Supporting basic research involves investment of confidence and money in the researcher, an investment in brains and experience. Stated another way, supporting basic research requires a willingness to take the calculated risks so clearly indicated in Northwest Area Foundation's support of some of the early research at Cedar Creek Natural History Area. An interesting example of such risk taking is the early research which led to the current widespread use of radio-tracking of wild animals. The rewards of such risk taking become clear over the years as research findings are applied to protecting and improving human life and our environment."

A. A. Heckman, former Executive Director and President, Northwest Area Foundation.

Northwest Area Foundation is one of several grant-making bodies which have supported fundamental research projects at the Cedar Creek Natural History Area. The reserve, located 30 miles north of the Twin Cities, is a unique 5,700 acre outdoor research laboratory administered by the Minnesota Academy of Science and the University of Minnesota. Significant scientific findings made in the reserve have established it as a field laboratory of international renown.

Periodically, the Foundation likes to look at programs which it has underwritten in the past to see what has become of them. This article will briefly review the two major Foundation-supported projects at Cedar Creek. Both have contributed considerable data to the "storehouse of knowledge" and have had an impact on scientific research worldwide.

STUDY OF THE MOTILE RESPONSES OF ANIMALS TO RADIATION FIELDS AND TO OTHER PHYSICAL AND BIOLOGICAL FACTORS IN THE NATURAL ENVIRONMENT (1959–1965)

This project, which resulted in the first "successful" program to track the movement of wildlife with radio transmitters, revolutionized the study of animal behavior. It also is a prime example of what a foundation ought to do — use its limited financial resources as seed money to enable projects, which are oftentimes risky, to develop into successful, ongoing programs.

In 1957 the Soviets launched a dog into space and monitored its behavior with radio transmitters. Impressed with the Soviet mission, Dr. Dwain W. Warner, a University of Minnesota zoologist, began to think in terms of monitoring animals in their natural environment. At the time, biology lagged behind the other sciences in the ability to gather reliable statistical data. Biologists could only tag or band an animal or bird and note the starting and ending points of their travels. What happened in between? What environmental factors influence animal mobility? Interested University field biologists met with faculty members from the Departments of Mechanical Engineering, Biophysics, Physics and Electrical Engineering to discuss the possibility of developing a system which could provide the answers to these important questions.

In 1958 project coordinators Dr. Warner and John Tester, a Ph.D. student and Assistant Scientist at The Bell Museum of Natural History, approached the National Science Foundation (NSF) for support. The NSF responded negatively — the project was "too wild", it claimed, and offered little assurance of producing results for publication within the near future. Discouraged but still determined, Warner and Tester approached A. A. Heckman, then Executive Director of the Foundation. Heckman, impressed with the idea and the interdisciplinary nature of the project, encouraged the University to submit a grant application. In 1959 the Foundation awarded the University a $40,000 grant to begin the project; this was the first of two grants.

Dr. Warner described the situation at the time in these words: "Skeptics were everywhere. But we were excited about the concept and refused to believe that it couldn't be done. Fortunately, the Foundation was willing to take a chance."

While earlier attempts had proven that radio-tracking was possible in theory, scientists and engineers had yet to perfect the techniques and instrumentation needed to obtain reliable data. At Cedar Creek, failures far outnumbered successes during the initial years. Technical problems were common; transmitters were often unreliable. Larry Kuechle, a University of Minnesota engineer who designs transmitters, estimates that the early transmitters were only ten to thirty percent reliable. Engineers were confronted not only with the problem of designing functional transmitters, but transmitters which did not interfere with the animal's normal behavior. Dr. Warner summarized the early years, "It's a wonder we obtained any data, but we were happy with what little we did get."

In the early 1960s as University engineers, under the direction of William Cochran, perfected the instrumentation, field biologists monitored the movements of snowshoe hares and other small animals. One of the difficulties with the system was that it required field monitoring of individual animals. Biologists began to ask, "Is it possible to track several animals around-the-clock?" Cochran

David Smith, a University of Minnesota graduate student in wildlife biology, and his Nepalese assistant Prem Badhur Rai attach a Cedar Creek collar on a tiger in Nepal. The Tiger Ecology Project (1975–81), funded by the World Wildlife Fund and the Smithsonian Institution, sought to provide scientific data with which wildlife biologists can devise management plans to preserve the magnificent jungle carnivore.

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claimed that such a system could be devised and proceeded to implement the world's first automatic tracking system using two permanent antennae and old World War II receivers. The system, capable of monitoring 50 animals at a time, became operational in January 1964.

The project began to yield dramatic results by the mid-1960s. Within the span of a few years, biologists learned more about certain species of animals (red fox, raccoon, barred owl and snowshoe hare) than had been previously known. They were able to answer questions on "home range," dispersal, predation, disease spread, evaluation of census techniques and animal reactions to various environmental factors.

Project researchers began to publish their findings in the early 1960s. As the number of publications increased and personnel addressed scientific gatherings throughout the world, the project at Cedar Creek attained widespread recognition. Government agencies, which saw the system as a tool to answer various questions, funded specific research projects at Cedar Creek. For example, the Atomic Energy Commission funded a project to determine the effects of sublethal levels of ionization radiation on animal behavior. The National Institutes of Health funded several projects analyzing how diseases are spread.

Other federal agencies which eventually supported research at Cedar Creek were the U.S. Public Health Service, the U.S. Fisheries and Wildlife Service, the Office of Naval Research and the National Science Foundation. By 1965, federal agencies had awarded over $480,000 for research projects at Cedar Creek. This figure is far in excess of the $166,134 which the Foundation contributed from 1959–1965 toward the development and implementation of the system.

In summarizing the Foundation's impact on the project, Kuechle states: "The Foundation was the catalyst. It enabled us to make the transition from an idea in somebody's mind to a working tool capable of providing information necessary for answering questions concerning animal behavior and wildlife management."

Today, the University of Minnesota's biotelemetry (radio-tracking) program is the largest in the world. Since 1967 federal and state government agencies alone have pumped over $5.6 million into projects conducted at Cedar Creek or based there. (This figure includes a recent National Science Foundation $1.3 million five-year grant for Long Term Ecological Research.)

The Cedar Creek research has influenced biological studies the world over. Over 50 scholarly articles, many of a technological nature, have been published on the biotelemetry research. These articles are frequently cited in wildlife behavior studies performed elsewhere. In addition, many countries have established similar programs, many with the assistance of program personnel or people trained at the University of Minnesota.

Program engineers continue to be pioneers in the design of technological equipment. They have designed implant transmitters for animals to which transmitters cannot be externally attached. They have also experimented with transmitters that monitor physiological changes. Dr. Donald Siniff, Professor of Ecology and Behavioral Biology, recently described this new development, "It's an important area in the future of radio telemetry. The changes in heartbeat can be attributed to stress, which will give insights into predator-prey relationships, the problems of animal overpopulation and many other behavioral aspects of animals." Engineers have also experimented with satellites in tracking large migratory animals and have developed a portable automatic tracking system.

In terms of actual biotelemetry research, recent years have witnessed a shift away from fundamental research to applied research oriented toward problem-solving. Consequently, the majority of research projects, although based at Cedar Creek, are conducted elsewhere. Program personnel have contracted to do studies throughout the United States and the world. From 1975 to 1981, they worked with the Smithsonian Institution and the World Wildlife Fund to study Bengal tigers in an effort to preserve the endangered tigers from extinction. Since 1967, the National Science Foundation has awarded the University of Minnesota over $1.3 million to analyze wildlife population dynamics of the Antarctic region, a region characterized by a delicate ecological balance. Recently, the University commenced a study of wild horses in the western plains to evaluate the Bureau of Land Management's census techniques in the hope of formulating a policy to deal with the wild horse grazing problem.

In reviewing this article and the biotelemetry project, Dr. Richard Caldecott, Dean of the College of Biological Sciences at the University of Minnesota, writes: "Mr. Heckman's introductory quotation eloquently expresses the view held by scholars as to the importance of fundamental research. Many of us at the University view as providential the decision of the Foundation to provide funding for the radio telemetry project after it was rejected by a federal agency. The fact that research centers around the world have adopted the methods developed at Cedar Creek in their own behavioral research is mute testimony to the wisdom of the Foundation Directors and the importance of their autonomy."

SOME ENERGY RELATIONS OF TERRESTRIAL ECOSYSTEMS (1957–1961)

What happens to solar energy that lands on the landscape? How efficiently do various plant communities trap solar energy and store it in the form of organic matter or biomass? Are native plant communities more productive than managed communities? Does the kind of vegetation affect the rate of water loss from the earth's surface? These were the questions which a group of scientists under the direction of Dr. Donald B. Lawrence, Professor of Botany at the University of Minnesota, sought to answer during the course of this research project.

In the mid-1950s, scientists had yet to study the energy utilization of natural terrestrial ecosystems. (Similar studies of natural aquatic ecosystems and managed plant communities — agricultural crops and tree plantations — had been made in previous years.) In 1957 Drs. Lawrence and J. Roger Bray, Visiting Lecturer of Botany at the University of Minnesota, approached the Foundation for financial support for such an undertaking. The Foundation, recognizing the study's potential application both to efficient and profitable land use and water conservation, awarded a two-year grant of $24,840. A second two-year grant of $61,047 was awarded in 1959.

The studies at Cedar Creek focused on two areas — biomass production and water use of various plant communities. Using maize as a standard for productivity comparison, the scientists periodically sampled the chlorophyll content of designated specimens to determine which plant communities best produce biomass. The water use studies involved transplanting native swamp vegetation (herbs, shrubs and trees) into large tanks so that water loss could be measured directly.

While much new data resulted from the project, two very significant contributions to scientific knowledge emerged from the research:

1) By extracting the chlorophyll from the bark of aspen and other trees, the researchers demonstrated that deciduous trees carry on photosynthesis throughout the winter months.

2) The research team demonstrated that the type of vegetation on a unit of landscape has a tremendous impact on the rate at which water is evaporated (or transpired from plant surfaces.) This finding disproved a longstanding conviction that the rate of water loss from the landscape (regardless of whether covered by water or vegetation) was the same under given environmental conditions of temperature, humidity, wind, etc.

Research on energy utilization continued on a much more modest scale after the second grant expired in 1961. Scholarly publications based on the data gathered during the research phase continued until 1967. In all, 16 articles were published on the research conducted at Cedar Creek.

The project's most significant impact on the scientific community, however, was the International Biological Program's decision to adopt the project's theme as its own. (The International Biological Program, a program to study the biological basis of productivity and human welfare, was established by the International Council of Scientific Unions in 1964.) Dr. J. Derrick Ovington, a British botanist at the British Nature Conservancy who spent a year working on the Cedar Creek project, was impressed with the study's methodology. In 1964, he was instrumental in persuading the International Biological Program to study the productivity of natural ecosystems throughout the world. The Program occupied the world's biologists for ten years and had a major impact on biological scientific direction.