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DEPOSITORY

ENVIRONMENTAL RESEARCH RESERVE NETWORKS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON THE ENVIRONMENT AND THE ATMOSPHERE

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

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ENVIRONMENTAL RESEARCH RESERVE NETWORKS

THURSDAY, JULY 28, 1977

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON THE ENVIRONMENT AND THE ATMOSPHERE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. George E. Brown, Jr., chairman, presiding.

Mr. BROWN. The subcommittee will come to order.

We will have, as we not too infrequently do, some difficulties because of floor action starting at 10 this morning, but I think the best thing is to proceed and hope that we will not have too many problems with members being detained on the floor, and that they will be coming to the subcommittee.

The Environment and the Atmosphere Subcommittee's hearings on environmental research reserve networks which we are starting today I think represent a new and important area of activity for the committee. Research reserves are field sites representative of important natural systems which can be used for long term experiments in a broad range of disciplines, including geology, wildlife, vegetation, aquatic systems, and meteorology. The data obtained from these experiments, in tandem with that assimilated through years of similar studies, offers a unique national resource for understanding and learning to control man's effects on the environment and for advancing national environmental goals.

The hearings today and tomorrow will focus on what lands are available for research and what their status is in terms of long range protection. Because there has been some apparent confusion about the intent and focus of these hearings, I would like to make it clear that it is not our intent to consider legislation concerning protection of natural diversity or the President's Natural Heritage Trust program which is currently being developed by an interagency staff for the President. This subcommittee will hear testimony on several attempts to create a coordinated network of research sites—including the international biosphere reserves, the Federal Research Natural Areas systems, the proposed network of Experimental Ecological Reserves, and intra-agency groupings, such as ERDA's National Environmental Research Parks.

I might insert parenthetically that all of this bears on the other environmental research and development interests of the committee, as evidenced by our recent hearings on the coal cycle which explored the health and ecological impact of coal fuel cycle. Research parks

such as are in operation provide possibly the only and certainly the best way of establishing baseline data with regard to the pollution impact of these other sources.

Today, we will hear testimony from representatives of ERDA and from the Department of the Interior. Our first witness will be Dr. Brisbin of the Savannah River Ecology Laboratory and he will be followed by Dr. James Liverman, who is head of the Environment and Safety Division of ERDA. A panel of witnesses will follow with Dr. David Reichle from Oak Ridge, Tenn., and Dr. Burton Vaughan from the Pacific Northwest Laboratories, Hanford, Wash. The National Environmental Research Park concept seems to be growing stronger within ERDA and we look forward to your comments on this program.

The Department of the Interior has extensive land holdings and a great deal of research has been conducted on their lands. Dr. Ted Sudia of the National Park Service will be accompanied by Mr. Marc Nelson of the Division of Wildlife Refuges and Mr. James Monroe from the Bureau of Land Management. We welcome your views on the status of lands for long term environmental research and what recommendations you may want to provide as to their protection for future research.

A network of sites would insure that experimental areas adequately represent the variety of ecosystems in the United States. It would provide a mechanism to coordinate the use and development of the sites as well as the planning and application of the research performed at them. These networks of observational and experimental environmental research reserves may eventually provide—through basic, long-term field studies, monitoring, and associated laboratory studies—detailed knowledge of basic natural life support systems, and provide a vital data base for setting the necessary health and environmental protection standards.

Mr. BROWN. I would like to invite Dr. Brisbin to come forward at this time. You may proceed in the usual fashion, Dr. Brisbin. Your full testimony will be inserted in the record and you may summarize or abbreviate if you wish or read it in full.

STATEMENT OF DR. I. LEHR BRISBIN, SAVANNAH RIVER ECOLOGY LABORATORY

Dr. BRISBIN. Thank you.

Mr. Chairman, it is a pleasure and an honor to be here and participate in what I think is a most important and timely issue of environmental concern.

What I would like to do to start off this morning is first describe some of the basic philosophy and the background thinking that has been incorporated into the National Environmental Research Parks, or as we like to call them, NERP's, of the U.S. Energy Research and Development Administration. In particular, I would like to begin by indicating how the NERP concept has been derived from some of the very most basic principles of the field of modern ecology as we know them.

What is needed is a very basic approach to the natural world that considers a hierarchy of levels of complexity of organization ranging

from very simple systems like atoms up through the more complex systems such as populations, communities, and ecosystems with man as an individual organism sitting somewhat in the middle.

The most important point is that at each of these levels of organization we have systems that are structurally and functionally integrated as unified wholes and this is more obvious at some levels than at others. Obviously, the organs of your body act as a unified whole but this is less obvious in the case of more complex systems such as the eastern forest where, for example, the extermination of the wolf several decades ago may be considered as having been somewhat analogous to the removal of a kidney from a patient's body. In either case the "patient" can survive the surgery but life is certainly not quite the same afterward.

For our purposes here today with respect to National Environmental Research Parks, I will be dealing with the ecosystem level of organization. In particular, I would like to use the flow or movement of energy as a tool to dissect, if you will, this ecosystem "patient" into its component "organ" parts and indicate how the energy derived from sunlight is captured by green plants and passed on through a food chain of herbivores, carnivores, and decomposers.

The important point for our discussion is to distinguish clearly where the energy resource originally comes from. A natural system is defined as one that relies solely on sunlight energy as its source of energy input. Examples of natural systems include forests, meadows, ponds, streams, and jungles. All you have to do is leave such systems alone, let the Sun shine on them, and they can keep themselves fertilized, recycle their wastes, and maintain and reproduce themselves.

A developed system, on the other hand, needs some form of overhead energy subsidy. It cannot exist on sunlight energy alone. Examples of these would include cornfields that have to be harvested by mechanical equipment with gasoline inputs, fertilized beef cattle pastures and, of course, your automobile. You obviously cannot just let the sun shine on your car and expect it to keep running and maintain itself.

Of great importance to us is the fact that the developed systems of today's world pay their overhead energy subsidy largely by parasitizing the stored energy reserves of either present or prehistoric natural systems. Millions of years ago, the sunlight energy that fell on this Earth was captured by the giant ferns and other vegetation of the carboniferous forests and was transformed into the bodies of dinosaurs and decaying vegetation, and this same energy, now in the form of fossil fuels, is now being used to pay that energy overhead subsidy of our developed systems.

The analogy I like to use to describe this arrangement is one of a thrifty Dutch uncle who is scrimping and saving to put money in the family bank account over millions of years and now there is a prodigal son on the scene who is spending the family bank account like there is no tomorrow. As indicated by the double arrow in the middle, the prodigal son—today's developed system—is now also harassing the Dutch uncle—the world's natural systems—in such a way that it is getting increasingly harder for him to even earn a living.

To get back to the point at hand, a National Environmental Research Park—NERP—site and program is plainly and simply one which is designed to study the interaction between natural and developed systems as we have just described them.

Thus, at the four present sites of the National Environmental Research Parks of the Energy Research and Development Administration, we have to have components of both developed and natural systems. Without either one or the other it is a no-go situation. This, then, is one important way in which National Environmental Research Parks differ clearly from the system of national parks in our country. The latter, like Yellowstone, Yosemite, or Everglades, have only the natural system component within them and not the developed system component, as do the NERP's. This approach also helps us to assure those concerned with future industrial development or similar activities at some of these sites, that their plans for the future are not only compatible with but are actually essential to the successful realization of NERP goals. The message then is that to be important for ecological studies a research site need not necessarily be characterized by undisturbed pristine natural beauty. Rather, it is often just as essential for us to take measures to protect for study classic examples of sites of environmental disturbance, along with appropriate undisturbed natural systems to serve as reference points. That is exactly the approach that we are using in the NERP system.

In conclusion, I would like to describe some of the research program of my own laboratory at the ERDA Savannah River plant near Aiken, S.C. As you may know, this site was designated as the first National Environmental Research Park in 1972, and I would specifically like to describe for you those NERP studies at the site dealing with the interaction between production reactor effluents—developed system—and a cypress swamp—natural system.

The Savannah River plant consists of approximately 300 square miles of land that were set aside in 1952 with restricted public access since that time, due to the safety and security restrictions required for nuclear weapons production facilities and radioactive waste storage areas.

Over the past two decades, these reactor facilities have released certain quantities of heat and occasional accidental spills of radioactive materials into the natural stream water courses that drain across the area eventually running into the Savannah River to the south.

The specific study I would like to describe as an example here deals with the mechanisms by which a 30-square-kilometer band of cypress swamp has apparently acted over the years as a giant heat exchanger and radionuclide filter, receiving the stream effluents and passing them on down stream to the Savannah River, cleansed of their radioactive wastes and cooled to ambient temperatures all at no cost to the taxpayers. You see, being a natural system a cypress swamp can run on sunlight energy alone, just leave it alone, and without any energy subsidy or overhead cost of dollars it can apparently carry out these functions.

What we did then was simply to select one of these reactor effluent streams and study it—setting up transects and collecting samples at the point where the stream enters the swamp "filter" itself. But after

locating our study area it became apparent that some of these swamp systems, by virtue of mud, insects, and quicksand, offered resistance to being entered and studied. Our best solution to these kinds of problems have often involved finding some enthusiastic students who want to learn ecological field techniques. We find that, in most cases, these students will work longer and harder and in some cases actually free of pay, as compared to most salaried technical assistants. The reason is simply because they are doing thesis work or are otherwise involved in the field of research and believe that it is important to get involved in this kind of data collection.

The idea is to pull together all of the information from the different swamp system components, ranging from the very small seemingly insignificant grazing herbivores like mice up through the larger predators that might eat them, such as foxes, bobcats, hawks, owls, or snakes, and every time we come to consider a new species component or population in our swamp system we have to conduct more studies so that in the final analysis we can put together an integrated picture of the total swamp ecosystem as a unit, and through this procedure, under stand how it operates as the natural system component of our NERP study. The effluents from the production reactors of course, serve as the developed system components.

In this particular case, as I have said before, the safety and security restrictions associated with these nuclear facilities have so far at least, made these lands available to us for long-term study with no need up to this point for any particular protective legislation. However, a problem that has faced us in the past, and one that may come to face us again in the future, is that prior to the designation of our NERP facility in 1972 it was extremely hard for us to justify the retention of some of these lands as being programmatic to AEC or ERDA agency missions. As a result, the GSA determined safety and security restrictions on the basis of very strictly defined radii that were drawn about the reactor systems with the very clear implication in their point of view, that those lands falling outside of these radii could generally be considered as nonessential to our agency's specific mission at the site. As a result, back in early 1972, before we had a National Environmental Research Park designation, and in connection with the Nixon Legacy of Parks program, we lost a total of 6,021 acres which were transferred directly to GSA and then subsequently to the U.S. Forest Service. An additional 2,487 acres were also transferred at that time to Barnwell County, S.C., on our eastern boundary and this has served as the site for the Barnwell nuclear fuel reprocessing plant. That represents a total loss of about 4.4 percent of the total land in the area of the Savannah River plant at that time.

I might indicate here, the green areas represent a total of 953 acres within the site which we call habitat reserve areas which are left inviolate and as reference points, representative of the kinds of habitat that we deal with as natural systems on the plant.

While the Barnwell Nuclear Fuel Plant on our boundary could certainly be welcomed and serve as a developed system component whose impact we could study in our NERP program, the problem is that since we did not have at that time an extant National Environmental Research Park designation at the site, these 8,000 or more acres

of extremely valuable research land have now been lost from our present total integrated program of environmental study at the Savannah River plant. What we now have is a situation where the land is under the control of several different kinds of agencies and groups and the entire site is no longer intact as a unit for an integrated program of environmental study.

Unfortunately, among those lands lost from our research park was a most unique wetland habitat known as Craig Pond. This was one of the primary water fowl roosting and concentration areas of the area, and the southern half of it was transferred to Barnwell County and it has now been opened for public duck hunting which has, of course, caused significant disruptions in our long-term studies of the water fowl of the area. This wetland area also included a unique habitat with respect to vegetation including that of the carnivorous pitcher plant.

Because of situations like the one I just described, I feel that any future legislation designed to protect land for ecological research should take a particularly strong look at the possibility of also restoring lands wherever possible that have been lost from sites which may already enjoy some measure of programmatic protection, such as our ERDA research parks.

In conclusion, this has been a quick overview of the general philosophy and principles behind our ERDA system of National Environmental Research Parks, with the particular example here being a cypress swamp at the Savannah River plant in South Carolina. But I do not want your thinking to become particularly concentrated on any one particular habitat or on any one particular governmental agency or any one environmental problem. In the Alaskan Arctic, for example, where the issues are oil pipelines and tanker terminals rather than cypress swamps and nuclear reactors, these very same basic ecological principles which lie behind the NERP study at the Savannah River plant are now coming to the fore in our discussions concerning the immense research value of the lands at Cape Thompson which you may know was the site of the former AEC Project Chariot. These discussions are also involving such groups as the Department of Interior, Navy, and the various parties to the Alaskan Native Claims Settlement Act.

I think in conclusion then that in the final analysis it is the very breadth of these topics illustrated here which again indicates the very basic nature of the ecological principles upon which such programs are being based.

Mr. Chairman, again, I thank you for the opportunity to come here.

Mr. BROWN. Thank you, Dr. Brisbin, that is a very helpful discussion and gives us some perspective within which we can better understand the subsequent material.

Let me just ask you one thing—you of course had to simplify the presentation here into general systems kinds of things, but with regard to the Savannah River plant, you indicate that the main interaction between the plant and the pristine environment is the effluents from the plant. Have you been able to protect this area against other kinds of effects—highways, buildings, the other sorts of developments

that occur that impinge upon natural areas aside from just simple plant effluent type of impacts?

Dr. BRISBIN. Yes, within the limits of what we are trying to do within the National Environmental Research Park. Again, maybe I ought to clarify that the word "protection" in this case does not mean that there will be no highways, no buildings, or no new waste storage tanks. "Protection" in this sense of the word means that if and when there are new waste storage tanks, buildings, or highways, that an integrated environmental research program will become part of that program from the time that it first goes on the drawing board. Then we conduct our environmental baseline studies along with such a program of waste storage or highway development and the environmental studies are closely integrated with them. That is the special meaning of the word "protection" in this case.

Mr. BROWN. All right. I think we will go ahead with Dr. Liverman and get his perspective on this.

[The prepared statement of Dr. Brisbin follows:]

TESTIMONY CONCERNING ENVIRONMENTAL RESEARCH RESERVE NETWORKS,

BEFORE THE HOUSE SUBCOMMITTEE ON THE ENVIRONMENT AND ATMOSPHERE,

JULY 28, 1977

Presented by:

I. Lehr Brisbin, Jr., Ph.D.

Savannah River Ecology Laboratory

and

Institute of Ecology of the University of Georgia

Mr. Chairman, it is indeed a pleasure and an honor for me to be able to participate in these hearings concerning environmental research reserve networks. I would like to lead off this morning's session with a presentation of some background information concerning the design and philosophy behind the designation of National Environmental Research Park (NERP) programs at various sites of the United States Energy Research and Development Administration (ERDA). In this presentation, I would like to first show how the NERP concept was derived from a consideration of some of the most basic principles of modern ecological theory as we know it today, and then indicate how such NERP programs have become particularly relevant to the ERDA agency mission of evaluating, quantifying and predicting environmental problems associated with the production and utilization of energy in our nation. I would then also like to indicate how such NERP programs might similarly become relevant to the applied missions of other federal agencies as well. Finally, I would like to conclude with an example from my own laboratory at the ERDA Savannah River Plant near Aiken, South Carolina, and indicate how ecological research at that site, which was the first National Environmental Research Park to be designated in the nation, has been enhanced by the operation of our NERP program and how our environmental studies there might have been even more effective if such a NERP program had been instituted even earlier in time.

The derivation of the NERP concept from the basic principles of modern ecological theory is discussed in detail in the attachment (Appendix I) to this testimony. Basically, this involves a definition of the word "ecology," based on a consideration of the natural world as a gradient

of levels of complexity of organization extending in an unbroken series from atoms to ecosystems. The classic definition of ecology as "the relationship between plants and animals and their environment" may be applied to this scheme by simply defining the word "environment" as representing those levels of organization other than the one being discussed (see Figure 2 of Appendix I). The most all-encompassing and complex of all of these levels of organization as we know them today is of course, the ecosystem, and it is at this ecosystem level of organization that many of our societal problems in such areas as the energy-environmental conflict are experienced. It is therefore at this most important ecosystem level of organization that the basic concept of a NERP must be most strongly developed.

One approach to the consideration of an ecosystem as a structurally and functionally integrated unit of nature is illustrated in Figure 3 of Appendix I. Basically, this approach considers the ecosystem as being composed of a series of interconnected compartments of energy (and/or matter), with interconnecting flows between them. This so-called "boxes and arrows" approach to the study of ecosystem structure and function is basic to not only our understanding of the movement and utilization of energy in the natural world and man's society, but it also points the way to a better understanding of the processes by which man's activities can and have impacted upon the world's natural ecosystems by modifying or altering the rate or pattern of flows and/or storage of matter in these various boxes and arrows. In particular for example, the movement of pollutants through ecosystems becomes readily understandable and most importantly, predictable, once the "roadmap" of boxes and arrows have been established for the ecosystem in question.

In order to develop the NERP concept from the above considerations, it is necessary to distinguish between those ecosystems which rely solely on sunlight energy alone as their energy source and those which cannot rely on sunlight energy alone and must therefore be provided with some form of additional energy subsidy in order to maintain themselves. Those ecosystems which can exist on the use of sunlight energy alone are the so-called "natural" systems and include such examples as forests, ponds, meadows, streams, tropical jungles, deserts, and oceans. Those systems which cannot rely on sunlight energy alone however, are termed "developed" systems and include mechanically harvested corn or wheat fields, artificially fertilized beef cattle pastures and your automobile. It's painfully obvious for example, that your automobile cannot run and maintain itself on sunlight energy alone but rather constantly needs to be subsidized in the form of gasoline and the labor of increasingly expensive automotive mechanics. An extreme example of a developed ecosystem is Manhattan Island; in such a case, there is little doubt that the few green trees and other plants of Central Park do not manufacture enough food from sunlight energy

alone, to feed the residents (humans) of that system, whereas only 500 years earlier, the natural forest that occupied that area was well able, using sunlight energy alone, to not only feed all of its resident herbivores and predators but also to reprocess and recycle their wastes and thus maintain an effective balanced steady state over a considerable period of time.

As illustrated in Figure 5 of Appendix I, the developed systems of today's world are essentially parasitizing the food energy and fossil fuel reserves that have been stored up by the natural systems of modern times, as well as those of our prehistoric past. Of greatest concern however is the fact that it is becoming abundantly clear that not only are our present developed systems parasitizing the productivity of adjoining natural systems, but they are also harrassing and impacting upon such natural systems in such a way that their ability to capture sunlight energy and produce food and fuel reserves is being decreased. A good example of this process is the impact of acid rainfall resulting from atmospheric contamination by developed systems of our industrialized northeast. It is now becoming apparent that such acid rainfall is actually diminishing the green plant productivity of many forests and other adjoining natural systems of the eastern United States.

As indicated by the central double arrow in Figure 5 of Appendix I, a NERP program is designed to study the interactions between natural and developed systems, not only in the ecosystems but at all levels of organization of the natural world. In order to accomplish such a task, a NERP program site must have available to it components of both natural and developed systems. In this way, National Environmental Research Parks differ significantly from our nation's National Parks which do not incorporate significant developed system components within their boundaries. It would not be possible to develop an extensive NERP program within the boundaries of the Everglades National Park for example, unless some developed system component such as a nuclear power station or an oil-well complex were developed at that site, within the natural sawgrass ecosystem. Furthermore, this philosophy insures those who plan to undertake industrial or other forms of development at a NERP site, that their programs are not only compatible with NERP goals but are absolutely essential to their realization! The important point of all of this is that in order to better understand the mutual impact and interdependence of developed and natural systems in the world today, we must move to insure that land is protected and programs developed at not only pristine sites of undisturbed natural beauty, but also at sites where the full impact of man's developed systems is being experienced and responded to by natural ecosystems and their inhabitants.

As an example of this process, I would like to now refer briefly to the NERP program at the Savannah River Plant near Aiken, South Carolina, where I have been personally involved in some of the field research as a member of the staff of the Savannah River Ecology Laboratory of the University of Georgia. The NERP program at that site includes among other things, studies of the impacts of production reactor effluents (developed system components) upon a cypress swamp ecosystem and its inhabitants (natural system components). These studies, as summarized on pages 88-90 of Appendix I, have indicated that over the past two decades, this swamp and its associated wetlands have been working patiently as a giant heat exchanger and ion-exchange filter, cooling these heated reactor effluents and cleansing them of their radioactive wastes before passing them on to the Savannah River downstream. All of this of course, has been performed as a service by the swamp at no cost to the taxpayers of this country since being a natural system, the swamp runs on sunlight energy alone and requires no subsidy of fossil fuels and/or dollars to keep itself fertilized, cleansed of wastes and maintained in a proper steady state.

Studies such as the one I have just described, have been made possible by the long-time protection and security of restricted access which has been provided at the Savannah River site since the time of its procurement as a research and development facility of the former United States Atomic Energy Commission in the early 1950's. At sites such as these, where safety and security considerations for nuclear facilities require strict control of public access and disturbance, little or no additional legislative action seems to be presently needed, in my opinion, in order to provide the protection required for these studies to progress. It should be emphasized here however, that the word "protection" in this sense in no ways implies assurance of freedom from disturbance of developed system impacts. As explained above, in fact, such impacts are essential for NERP studies to be properly designed and carried-out. The word "protection" in this sense rather refers to the fact that assurance and philosophical assent is given by the agency involved, in this case the Energy Research and Development Administration, that as developed-system programs are brought onto line and made operative at the particular site (e.g., new radioactive waste storage tanks, nuclear power parks, etc.), proper NERP-based ecological studies will indeed be designed and incorporated as integral parts of these programs from the time of their inception. To do so, moreover, is simply a fulfillment of agency obligations under the present letter and spirit of such laws as the National Environmental Policy Act, the Endangered Species Act and similar legislation. Without the specific designation of NERP programs at such ERDA sites, however, the ability of our agency to effectively defend the retention of such lands and research programs as being of programmatic interest to ERDA goals, has been often severely hampered.

In the early months of 1972 for example, a total of 8,508 acres or approximately 4.4% of the total land area of the 300-square-mile Savannah River Plant was lost from the control of our program when 6,021 acres were turned over to the GSA and later given to the United States Forest Service, and 2,487 additional acres were deeded to Barnwell County, South Carolina in connection with the proposed construction of the Barnwell Nuclear Fuel Reprocessing Facility. Now while the Barnwell facility certainly represents the kind of developed system component that could form the focus of a proper NERP study program, the fact that these lands were lost from ERDA control meant that when the Savannah River NERP facility was designated several months later in June of 1972, these lands were not included. Moreover, the boundaries which cut-off these lands have deprived us of the integrity of some of the most important sites for ecological research on our whole plant area. Craigs Pond for example, the best example on the entire Savannah River Plant site of a unique southeastern wetland habitat known as a Carolina Bay, was divided in half by the boundary which deeded lands to Barnwell County, South Carolina and only the northern half of this bay now remains within our NERP site. Another unique example of pitcher plant habitat known as Sarracenia Bay was also lost at the same time. Craigs Pond had also been one of the major night time roosting areas for the Savannah River Plant waterfowl population and the opening of the southern part of that bay to public hunting pressure has now caused complex changes in waterfowl habitat utilization and movement patterns on the plant area - changes which we feel may have negative impacts in terms of forcing ducks to now roost in less favorable wetland habitats deeper within the plant site where the probability of contamination from accidental radionuclide releases would be increased.

The point of this discussion is that if our NERP program had been initiated at the Savannah River Plant site prior to the time of the GSA Legacy of Parks land-aquisition efforts, such lands as those we lost might have been more effectively defended as being programmatic to our agency's mission to evaluate the environmental impacts of energy resource development and utilization as explained above. Almost certainly, any such land loss from an extant NERP program would only have been undertaken with a more adequate consideration and discussion of the environmental impacts and the needs for continuing environmental studies in coordination with on-site NERP programs, after such lands may change hands. At present, as stated above, the remaining lands of the Savannah River NERP site seem well secured for the time being, and in fact, over 953 acres of that land has now been specifically set aside and designated as natural habitat

reserve areas, which serve as undisturbed reference points of the major kinds of natural ecosystems found on our site. Similar programs including both the natural and developed system components for the other three NERP sites of the Energy Research and Development Administration are outlined in Figure I.

It is also of crucial importance to point out that the development of any program of NERP study such as I have described would be of only minimal value unless some form of programmatic financial assistance is also provided to insure at the minimum, the proper administrative support needed to maintain the integrity of the research site in question and secure its boundaries against unwarranted intrusion and disturbance. In the case of our own agency, site security is a fortunate by-product of the normal procedures for the operation of the Savannah River Plant area. However, it is almost of equal importance to also insure that some form of minimal funding be made available for the seeding and development of quality environmental research efforts. In the case of the Savannah River Plant, for example, a total of $215,000 has so far been provided to the site by the U.S. ERDA, for the sole purpose of developing and promoting NERP programs. Clearly distinct from the dollar support of environmental research per se these specially designated funds, which last fiscal year amounted to $75,000 at our site, are used for such purposes as: (1) providing travel support to bring scientists, students and educators to our site to learn of our program efforts and perhaps become interested in initiating related research programs of their own; (2) developing and equipping certain general support facilities such as laboratory trailers at field sites, for the use of visiting scientists; (3) providing support and promotion for various scientific symposia and meetings at which environmental information generated in NERP research programs is disseminated; and, (4) supporting certain baseline environmental assessment programs through which the quality and composition of the flora and fauna of the various NERP-site habitats can be censused and monitored over extended periods of time.

In conclusion then, I feel that it is important to emphasize that while the NERP thinking that I have been describing has so far operated exclusively within the programs of the U.S. Energy Research and Development Administration, the design of the NERP concept itself relates to the basic principles of the field of ecology in their broadest and most general sense and thus could properly be considered the domain of many other federal, state, or private agencies as well. Since the basic differentiation of "natural" from "developed" systems is made on the basis of the derivation of their energy resources, it is only natural that the first efforts at conceiving and designing studies of the interaction of these two should come from within a federal energy agency. However, now that these

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basic concepts have been established, it is important to realize that many other federal agencies might also have strong programmatic justifications for designating NERP programs and facilities at their own sites, in order to better study the interaction between natural and such developed systems as the mechanized agriculture and pest-control programs of the USDA; the timber management programs of the U.S. Forest Service; and, the grazing leases, coal, or oil-drilling leases of the Bureau of Land Management. As has been the case in our own ERDA National Environmental Research Park programs, I believe that the initiation and support of similar NERP research efforts by other agencies would prove not only to be of relevance to the specific programmatic missions of such agencies but would also be of particular long-term benefit to the best interests of all the people of this nation in terms of better assuring the development of the proper environmental expertise and understanding that will be needed to help insure the preservation of suitable environmental quality and stability in the years to come.

Figure 1. A tabular summary of some natural and developed system components and NERP research-study opportunities at four National Environmental Research Park sites of the United States Energy Research and Development Administration.

NATIONAL ENVIRONMENTAL RESEARCH PARK SITES AND STUDY OPPORTUNITIES

SAVANNAH RIVER:

- PRODUCTION-REACTOR EFFLUENTS ⟷ CYPRESS SWAMP
- HEATED WATER ⟷ RESERVOIR & STREAMS (BASS, TURTLES, ALLIGATORS)
- PINE TREE CULTIVATION ⟷ "SANDHILLS" FOREST ECOSYSTEM

IDAHO:

- CHEMICAL PROCESSING PLANT WASTES → SAGEBRUSH ECOSYSTEM
- CATTLE, SHEEP GRAZING → SAGEBRUSH ECOSYSTEM
- HERBICIDES, CHAINING → SAGEBRUSH ECOSYSTEM
- SHEEP GRAZING & PREDATOR CONTROL ⟷ COYOTES

HANFORD:

- WASTE DISPOSAL CRIBS ⟷ SAGEBRUSH ECOSYSTEM
- HEATED REACTOR EFFLUENTS ⟷ SALMON MIGRATION
- NUCLEAR POWER PARK ⟷ SAGEBRUSH ECOSYSTEM

LOS ALAMOS:

- RADIONUCLIDE WASTES ⟷ CANYON ECOSYSTEM

APPENDIX I

Reprint of an article entitled, "The Principles of Ecology and their Application to Environmental Problems Associated with the Production and Utilization of Energy", by I. Lehr Brisbin, Jr. Reprint from Population and the Environmental Crisis, Stephen White (ed.), Research Advisory Council, East Tennessee State University Press, Johnson City, Tennessee. 1975. pp. 72-91.

THE PRINCIPLES OF ECOLOGY AND THEIR APPLICATION TO ENVIRONMENTAL PROBLEMS ASSOCIATED WITH THE PRODUCTION AND UTILIZATION OF ENERGY

I. L. BRISBIN

Four years ago the advent of the first Earth Day placed a challenge before the citizenry of the United States, and especially before those within the field of ecology, to begin to address the issues of the establishment and future assurance of environmental quality and stability in this country. In the years which have followed since that time, this challenge has become even more pointed, especially in recent months, with the occurrence of a national energy crisis. With this challenge to make environmental concerns compatible with energy demand, national planners and scientists alike have found a need to return to the basic principles of ecological science and apply these principles to the problems which they are facing in this area. It is the purpose of this presentation to relate some of these basic principles of the field of ecology to these environmental concerns related to the production of both nuclear and non-nuclear energy.

Basic to an understanding of the fundamental principles of the field of ecology is an understanding of the broadest concept of the definition of the word "ecology" itself. The word "ecology" has long been defined as the basic relationship between plants and animals and their environment. Today, however, such a definition is probably much too limiting to be completely useful in all contexts in which the word is being applied. In its broadest sense, the word "ecology" signifies a philosophy or an approach to the natural world. This approach which is embodied in the word "ecology" is based on a gradient of levels of complexity of organization of naturally-occurring systems, as presented in Figure 1. Basically, this gradient includes systems ranging from the very simple atoms, molecules, and cells to larger and more complex units such as populations, communities, and ecosystems. The approach which we call "ecology" deals with

IN: Population and the Environmental Crisis, White, Stephen (ed.). Research Advisory Council, East Tenn. State University, Johnson City, Tenn. 1975. p. 72-91.

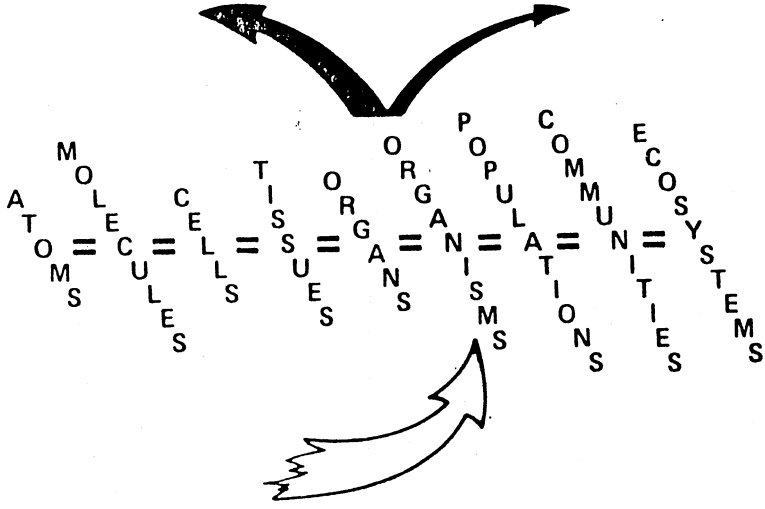

Figure 1. The gradient of levels of complexity of organization of the natural world. Man's understanding of this gradient, as indicated by the white arrow, began at the level of the individual organism and spread, as indicated by the black arrows, downward to less complex and secondarily, upward to more complex systems.

all levels in this gradient, even though it has been more commonly associated with those levels of higher complexity of organization. However, technical papers are now beginning to appear in the scientific literature, dealing with the ecology of the human skin, the ecology of the human mouth and ecological approaches are now being considered for use in studying the relationships between diseased and cancerous cells and tissues. In other words, it may not be so much *what* a man does, but rather *how* he does it, which makes him an ecologist, as opposed to an M.D., lawyer, zoologist, or botanist.

It is interesting to note here that man's understanding of this gradient, which began at the individual level of organization, as indicated by the white arrow in Figure 1, spread in both directions from the center of the gradient as man's understanding grew to include both smaller and less complex systems within his own body and also larger more complex systems outside of his body. As indicated by the black arrows in Figure 1, however, man's understanding of more complex systems developed at a much slower rate than did his understanding of less complex systems. This may be partly due to relative "visibility" of the systems involved. Man can apparently study and understand only those systems which he can "see" and that, of course, is largely a function of the instrumentation which is available to make such systems "visible" to him. When Hook, for example, invented the microscope, man's understanding began to spread to include cells and tissues. Later technological advances resulting in electron microscopes and other sophisticated electronic equipment has literally allowed man to "see" atoms and even smaller units. It has been only lately, however, that man's technology has allowed him to "see" larger more complex systems such as populations, communities and ecosystems. Technological advances in this area include earth-orbiting satellites, aerial infra-red photography and radio-tracking telemetry equipment. These technological advances have allowed man to now "see" and understand that like the bodies of individual organisms, populations, communities, ecosystems and even entire continents and oceans can act as single structurally and functionally integrated units.

The operation of each of these levels of organizations as single structurally and functionally integrated units is one of the most important aspects of understanding the importance of this gradient to current environmental problems. Such a principle is well understood at the more familiar levels of organization of the gradient. For example, there is little doubt that the human body (at the individual level of organization) acts as a single structurally and functionally integrated unit. A man's circulatory, digestive, nervous, and skeletal systems certainly do not walk around as individual entities, each doing a separate thing. Rather, they all act in consort as a single

unit, which is known as an individual organism. It has been much harder, however, for man to understand this same principle at the ecosystem level of organization. The eastern deciduous forest of the United States, for example, is just as much a single structurally and functionally integrated unit as is a human body. Yet few people gave as much thought to the extermination of an important predator population component, such as the wolf or panther, from that ecosystem as they would have given to the surgical removal of a man's kidney from his body. In neither the extermination of the wolf or panther from the eastern forest nor in the removal of a kidney from a man's body is the system totally destroyed by the "surgery" but there is little doubt that the system and all of its other component parts must have been drastically affected by the process in each case. At other points in this presentation it will perhaps be useful to return to such analogies in which basic principles, which are easily understood in more-familiar levels of organization, such as the body of an individual human being, are shown to also operate at less-familiar, more complex levels such as the ecosystem.

To make all of this compatible with the earlier more simplified definition of ecology as the relationship between plants and animals and their environment, all which must be done is to simply consider the word "environment" as referring to those levels of organization outside of the one under consideration. This process is illustrated in Figure 2. An individual deer standing in a forest, for example, has two parts to his environment. He has an *internal* environment consisting of the cells, tissues and organs which make up his body. However, the deer also has an *external* environment which consists of the deer population in which he lives and breeds, the community of other living populations such as squirrels, rabbits, birds, trees, grass, etc. which inhabit the forest, and finally the forest ecosystem itself. However, because the ecological approach can be applied at *all* levels of organization, this same approach can be used to consider the ecology of a cell sitting in a human liver! That cell also has two parts to its environment, its internal environment consisting of its component atoms and molecules and its external environment consisting of the tissues, organs and the individual organism within which it resides.

The relevance of this approach to environmental problems associated with energy production and utilization can be illustrated by considering how one of these levels - particularly the ecosystem - acts as a system comprised of interacting component parts, using energy as a means of demonstrating how all of the component subsystem parts are structurally and functionally integrated into a single unified whole. This is done in Figure 3. As is illustrated there, all energy for our natural ecosystms, as has been true for the past bil-

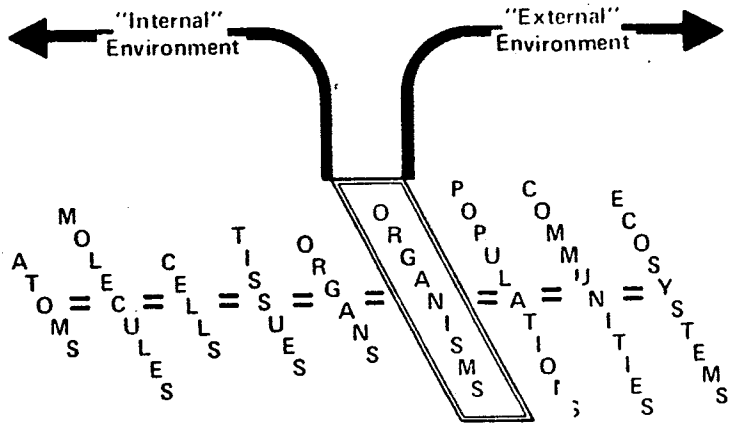

Figure 2. Consideration of the concept of "environment" as being those levels of organization outside of the one under consideration. An individual organism, for example, has both an internal environment, consisting of less complex and an external environment consisting of more complex systems.

lions of years, is derived ultimately from the sun. The calories of sunlight energy which impinge upon the earth's surface are then transformed and fixed into chemical bond energy by the green plants, or as they are known, "primary producers." Through the process of photosynthesis, the sunlight energy is transformed, in the presence of chlorophyll, and stored as chemical bond energy in the tissue of the plants' leaves, roots, stems, seeds or fruit. These plant parts are then consumed by herbivores and these grazers then capture the calories of energy from the plant tissue and incorporate it into their own bodies. A similar process then follows as these herbivores are consumed, in turn, by predators or as they are also known, carnivores. At each stage of this chain, energy may be bled-off to the decomposer level which includes the small fungi, bacteria and other microorganisms which break down dead bodies, excreta and other organic materials and utilize the energy contained in them for their own metabolic processes. In addition, energy is also lost as heat or respiration in each of these transfers, by virtue of the laws of thermodynamics which hold that no energy-transformation process can be 100% efficient. Each of the stages named in this process represents what is known as a tophic or feeding level. The sequence of trophic levels, as presented in Figure 3, forms a quite simplified linear food chain. In nature, however, these food chains often become infinitely more complex and diverse. One predator, for example, may derive his energy source from a number of different kinds of prey populations. In like manner, one prey species may be preyed upon by a number of different kinds of predators, and so forth. Thus what is illustrated in Figure 3 as a simple linear food chain may in nature actually be a quite complex food web.

Throughout the sequence of trophic levels, as illustrated in Figure 3, the basic unit of energy exchange is the calorie. Calories of energy thus flow in a one-way fashion from the sun through the producers to the herbivores, carnivores and/or decomposers and eventually leave the system as respiration heat. One-way energy imports and exports may also occur in certain systems.

As mentioned above, these energy-flow processes in natural ecosystems are usually quantified in terms of calories. Calories are also the basic unit of energy which are used to describe the intake of food in human diet and nutrition. However, society's energy consumption, in terms of electrical power, coal, gas or oil, are generally expressed in other terms such as B.T.U. units or kilowatt-hours, etc. Such units of energy measurement are directly convertible to or from calories by simple conversion factors, and it's possible that expressing energy transformations in common units might go a long way towards promoting an understanding of the commonalities of the energy prob-

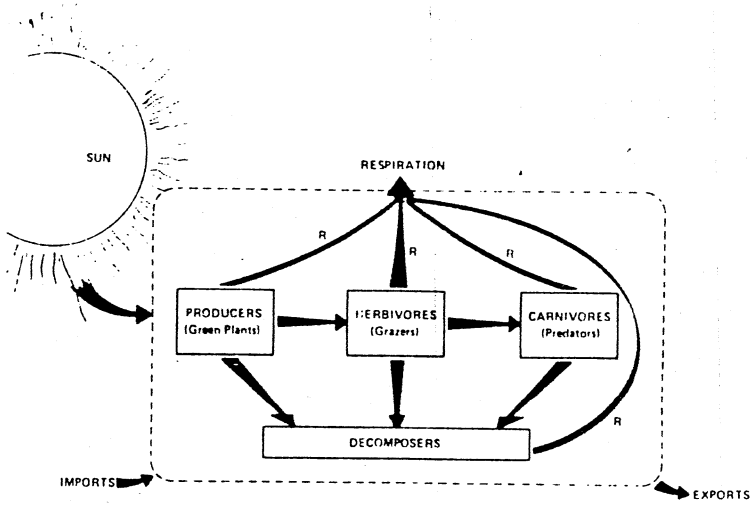

Figure 3. Energy flow through the major feeding levels of a generalized natural ecosystem.

lems shared between natural ecosystems and today's human society. Thus, the expression of energy in calorie units would help demonstrate the basic similarity of the kinds of transformations which occur when a mouse is eaten by a snake, a sandwich is eaten by a man, a gallon of gas is burned in a car or a lump of coal burned in a furnace. In all four of these examples, the potential chemical bond energy of the mouse, sandwich, gas or coal is released in a machine (the snake, man, car or furnace) and is then used to perform work of various kinds. Expressing all energy units in calories helps emphasize the fact that the same kinds of energy transformations are occurring in all four cases. On the other hand, expressing energy in different units in different situations, tends to change one's point of view when considering society's as opposed to nature's energy problems.

To bring these kinds of thinking into even closer coordination, H.T. Odum (1971) has proposed that dollars may also be interconvertible with calories in this process at an exchange rate of approximately 10,000 calories per dollar. This exchange rate was obtained by dividing our national energy consumption for a given year by the gross national product for that same year, as expressed in dollars. Using this conversion figure, some interesting calculations can be made. For example, present-day knowledge of the metabolic rate of trees and other forest vegetation suggests that, on this basis, an average healthy tree with a 50 m^2 crown, if left undisturbed in a forest, does approximately 128 dollars worth of work per year or an acre of healthy natural forest would perform approximately 10,360 dollars worth of work per year (Lugo *et al.*, 1971). All of this would be done at no maintenance or overhead cost to man. However, it should be emphasized that only a small proportion of this work would be directly useful to man in such forms as lumber, fruit or other products. The remainder of the value of the tree would lie mainly in its contributions of stability, diversity, and other benefits which are often difficult to quantify and consider as assets to human society unless adverse conditions of soil erosion or some other instability of the forest itself begins to create environmental problems for man.

A final important point concerning Figure 3 is that two main types of ecosystem components are presented in that representation. These are the "boxes" and the "arrows." The "boxes," as illustrated in Figure 3, represent storage compartments of energy which is captured and contained in the bodies of the plants or animals at the particular trophic level in question. The "arrows," on the other hand, represent transfer rate coefficients, which indicate the rate and direction in which calories of energy are moving between the storage-compartment boxes. The importance of distinguishing and quantifying the boxes and arrows of natural ecosystems will become obvious when it comes to considering the movement and cycling of

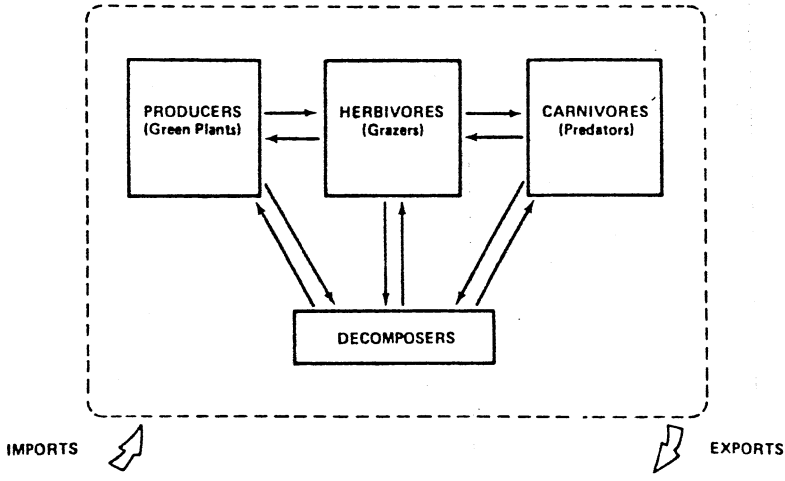

Figure 4. Generalized representation of the cycling patterns of matter and materials between the major feeding levels of a natural ecosystem.

matter in these same ecological systems.

What is true for the flow of energy through ecological systems is also largely true for the movement of matter and materials as is illustrated in Figure 4. This derives largely from the fact that matter and energy are interconvertible and thus matter may be considered as simply potential energy held in abeyance. There are certain differences, however, such as the fact that no matter, only energy, comes to the earth's natural ecosystems from the sun. There is also no respiratory loss of matter from these systems as was the case with the movement of energy. In addition, matter and materials can cycle both ways between trophic level feeding compartments while energy, as was mentioned previously, flows in one direction only. Thus, all of the trophic levels in Figure 4 might be connected by double-headed arrows.

This approach of studying and most importantly quantifying the boxes and arrows involved in ecosystem energy-flow and in matter and material cycling processes zeros-in on what might be one of the most important approaches to understanding and solving many problems of environmental contamination and pollution. This is because, by and large, such pollution or contamination stresses begin to occur in ecosystems when short-circuits or blockages occur in some part of these natural cycling patterns and pathways. This, in turn, might cause some substance such as a pesticide, radionuclide contamination, sulfur from coal-burning fossil-fuel plants or heavy metals such as lead or mercury to back-up and become concentrated in some storage compartment box. This then would cause the same kind of deleterious effects as would result from an accumulation of some such substance in a compartment of the human body. For example, mercury becoming concentrated in brain tissue, etc. lead or some other heavy metal in liver tissue etc.

Alternatively, short-circuits or shunts in natural cycling processes could cause harmful deprivations of some vital substance from some storage compartment of either our human body or our ecosystem. For example, a failure of sufficient nitrate or phosphate to recycle to the green plant producers of an ecosystem from the decomposers often places stress upon other parts of the ecosystem as well, just as a decayed tooth will often result in a headache or discomfort in other parts of a man's body. An analogy may also be drawn between a short-circuit deprivation in an ecosystem and a stroke which would restrict or short-circuit the supply of blood (and therefore food and oxygen) which is being carried to the heart muscle, brain or some other organ sub-compartment of the human body system.

Therefore, at the ecosystem level as well as at the better-understood level of our own human bodies, it becomes quite important to be able to draw and quantify these cycling pattern "roadmaps" and

try to establish as many realistic and *predictive* relationships as possible for these inter-connected boxes and arrows. This approach is exactly the one which is currently being used in many Atomic Energy Commision laboratories in an attempt to understand these cycling pathways in natural ecosystems adjoining nuclear power stations or other AEC facilities. In some cases, these processes can be studied in terms of the cycling of released radionuclide contaminants or, alternatively, radionuclide tracers can actually be introduced to better study and quantify the "boxes" and "arrows" of these food webs. Radionuclides are especially appropriate to perform this kind of analysis. This is because they are often more easily detected and quantified in standard laboratory counting equipment than are some other contaminants such as pesticides. While gamma-emitting radionuclides can often be detected and quantified from a living animal, the detection and quantification of pesticides or heavy metals, for example, frequently requires extensive grinding, homogenization and chemical extraction processes prior to analysis. This, of course, makes such analyses more difficult, time-consuming and expensive. It should be emphasized, however, that among the most important goals of such studies is an understanding of the actual pathways of the ecosystem "roadmap" itself rather than simply one radionuclide contaminant, pesticide, etc., alone.

A simple analogy may make the relationship between these cycling studies of different contaminants more clear. Such an analogy might describe how a very dangerous convict manages to escape from a local penitentiary and make his way into a hitherto unexplored piece of wilderness forested area. To find and capture this escaped convict will, therefore, be a most difficult task since it will involve extensive searches, surveying and mapping of the wilderness area into which he has escaped. This would then allow the mapping of water sources, hide-out caves, trails and roads which might be used, etc. Once this has been done, appropriate measures might result in the successful capture of the convict. If then, a second convict should later escape from the same penitentiary and enter the same wilderness area, his recapture would then be greatly simplified in comparison to that of the first. The prior existence of road maps and an understanding of the locations of caves, water sources, trails, etc., would allow the quick establishment of road-blocks and other measures which would allow and simplify the recapture procedure. The application of the analogy to ecosystem cycling studies should be apparent; the unknown wilderness area could be any ecosystem (a desert, forest, pond, ocean, etc). The first convict into the system could be a radionuclide, a pesticide, heavy-metal or some other form of contaminant. Once the "roadmaps" have been drawn to capture and analyze the movements of the "first convict," the process will

then be greatly simplified for similarly dealing with other contaminants (the "second convict").

Thus, it is entirely possible that current radionuclide cycling studdies may actually be providing important information and principles which will later prove to be of value in analyzing the environmental impacts of contaminants released by non-nuclear energy production through such processes as oil-shale extraction, off-shore oil drilling, strip-mining or the operation of coal or oil-burning power plants. In other words, the adaptation of current AEC radionuclide cycling studies to address the environmental impacts of non-nuclear energy production may not involve so much of a change in *what* is being done, as it would simply involve a change in *where* it is being done! Thus, cycling studies such as are now being conducted in the vicinity of nuclear power plants would simply be duplicated in concept and in approach in the vicinity of non-nuclear installations such as those described above.

What has been discussed so far and illustrated in Figures 3 and 4, are so-called "natural" systems. Natural systems may be defined as those which depend on sunlight energy alone for their energy input. In these systems there is no appreciable economic or energetic cost to man for their "overhead" maintenance or stabilization. Such natural systems include forests, grasslands, oceans, tropical jungles, arctic tundra, etc., and may be contrasted to so-called "developed" systems which are structured and maintained by auxiliary overhead energy inputs which are required over and above the sunlight energy which falls upon them, for purposes of maintenance, stability, etc. In most all "developed" systems today, this auxiliary overhead energy cost is being paid by man who must process and supply energy to them-- usually in the the form of fossil fuels-- to perform these functions. Examples of "developed systems" include cultivated crop fields which are dependent upon inputs of commercial fertilizer and farm machinery, towns, suburban areas and particularly cities. Fossil fuels usually provide over 95% of the auxiliary energy-input requirements of these developed systems--usually less than 5% of the auxiliary energy costs being paid by nuclear, wind, tidal, solar or geothermal energy resources. This is suggested by the dotted figure in Figure 5.

It is important to note here that population growth and particularly the expansion of man's society and technology on the earth seems to have provided an impetus for the conversion of natural to developed systems. The implications of such a trend are suggested by the trophic pyramids at the bottom of Figure 5. That is to say, the amount of food energy fixed by the producers is usually more than adequate to supply the needs of the herbivores which feed upon them. In turn, the herbiviores provide a more-than-adequate food base upon which

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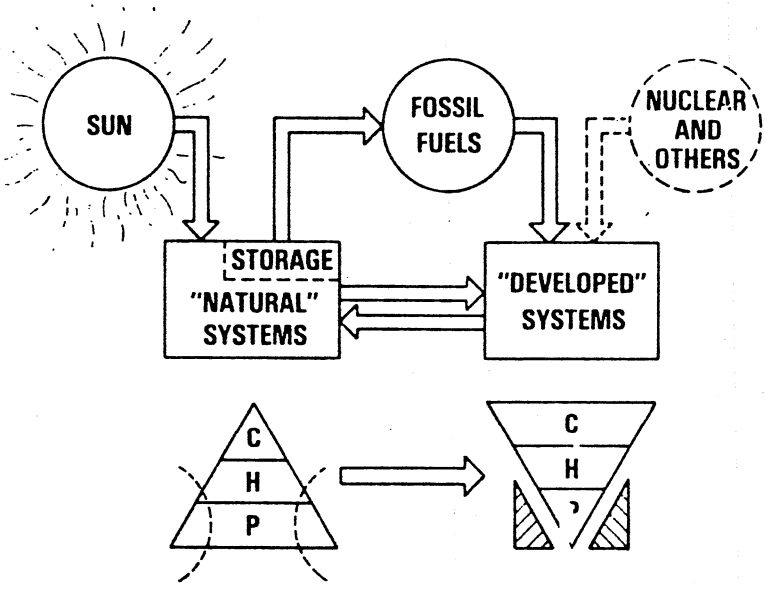

Figure 5. Some important relationships between natural and developed ecosystems. The pyramidal representations at the bottom of the figure suggest the relative stability of organization of feeding levels in the two kinds of systems. P = producers, H = herbivores, and C = carnivores.

the predator populations may rely. In developed systems, however, the producer food-base is usually not sufficient to supply all of the energy needs of the resident herbivore and predator populations. This results in an inherent system instability which must be counteracted by energy inputs which are "parasitized" from more stable natural systems which must give up some of their productivity to "shore-up" and support the food webs of the developed systems. The green plants of Central Park, for example, are scarcely capable of supplying all of the food needs of the herbivore and carnivore inhabitants of Manhattan Island. Therefore, additional energy resources in the forms of imported meat, produce, fossil fuels, etc., must be continually brought into the city from adjoining natural systems where the green plant producers provide not only an adequate but a superfluous food base. Such developed systems might, therefore, be thought of as "deficit-spending" economies. Calculations suggest that cities may show total metabolic rates energy-expenditure of up to 4,000 kcal/m^2 per day while natural systems usually show rates of only 40 kcal/m^2 per day (Odum and Odum, 1972). It is obvious that the natural productivity of the developed system is unable to supply the much greater metabolic energy requirement of such a developed system.

It is obvious that in order to stabilize the overall utilization and flow of energy through both natural and developed systems, it is necessary to have appropriate proportions of both in a given area or region. It would not be possible, for example, in the long run, to allow the metabolic requirements of developed systems in a given region to exceed the abilities of the natural systems of the same region to supplement the energy requirements to the extent needed to stabilize these "deficit-spending" economies. A pioneering attempt to calculate the relative proportions of landscape which are required to obtain such an overall regional energy stability has been made by Woodwell and Hall (1971) for the Long Island Sound region. These authors estimate that the 5,102 square miles of the 11 county Long Island Sound region (which of course acts as a deficit-spending developed system), would require clean undisturbed areas of either 20,000 square miles of eastern forest or 9,600 square miles of productive inshore estuaries or 430,000 square miles of open ocean in order to balance the Long Island regional energy maintenance demands in the long run.

An alternative to the preservation of such vast adjoining areas of natural system, of course, would be to begin to reduce the deficit-spending energy demand per unit land surface in the "parasitic" Long Island counties. The important point here is that such thinking must begin on a *regional* basis in terms of balancing the energy demands by establishing the proper ratio of developed to natural sys-

tems. Using similar procedures, Odum and Odum (1972) calculated that the minimum per capita acreage required for the maintenance of a quality environment is approximately 5.0 acres, in order to sustain a standard of living such as is realized in most of America today. In the state of Georgia, for example, there is an average of 10 acres per man and thus the state, as a whole, is still below its energy-based carrying capacity.

A further appreciation of the importance of green plant primary producers and their natural ecosystems in balancing world energy demands may be obtained by considering figures presented by Woodwell (1973), who indicates that on the basis of 1967 data, the total primary production fixed for one year by the world's green plants was approximately 20-fold greater than total world energy consumption during the same period - including all coal, petroleum, natural gas, nuclear energy and other sources.

A most important point which must be made here is that the fossil fuel energy resources--which, as was discussed above, supply over 95% of the energy supplement required by developed systems--are supplied to these deficit-spending systems through the most important processes of the decay and conversion of organic matter to such fossil forms as natural gas, coal, and petroleum in natural systems. As suggested in Figure 5, it is precisely this storage of energy, as mediated by the decomposer food chain of natural systems, which supplies the fossil fuels needed by the parasitic developed systems. These fossil fuel resources thus actually represent decayed and stored organic matter which has been put away by natural systems over the past millions of years. That is to say, the vast natural systems of prehistoric swamps, fern forests and jungles, whose remains today even underlie the North Sea and Alaska's North Slope, have been acting over the centuries like a thrifty "Dutch Uncle" - scrimping, saving and putting away world stores of energy which were originally bestowed by a prehistoric sun on the vast photosynthetic factories of the green plants of these swamp forests of prehistoric ages.

It is ironic that with this knowledge, we should still tolerate the vast ignorance and lack of study which characterizes the basic ecological processes associated with the decomposer food chain. While relatively great amounts of knowledge have been and continue to be collected concerning green plants, herbivores and predators, the small decomposer organisms which are found today in the litter, decaying leaves and organic matter of our forests, swamps and marshes still remain one of the least-studied and least understood portions of the world's natural systems. Yet it was this very component of our natural systems which was and perhaps still is responsible for the storage processes which have allowed the "Dutch Uncle" of

natural systems to lay up the stored energy "bank accounts" upon which our parasitic developed systems are currently relying today. To continue the analogy, our developed systems may actually be viewed as a profligate-spending "prodigal son," living on the past savings accounts of family ancestors. Unfortunately, however, in our present analogy, the "prodigal son" is not only spending up the stored family savings of energy but is also actively interfering with the present ability of the "Dutch Uncle" to continue to earn a living! This occurs in the form of numerous kinds of feedback interactions between natural and developed systems as are suggested by the double arrow between the two systems in Figure 5.

A good example of a negative feedback between developed and natural systems is the case of acid rainfall in the northeastern United States which is described at length by Woodwell (1974). In this case it appears that increasing acidity in rainfalls, which is apparently being caused by atmospheric contamination from fossil-fuel-burning power plants, automobile exhausts, etc., may be occurring at rates at which the resulting acidity of the rainfall may soon be leaching essential nutrients from the plants and soils of the "life-support" systems of the Northeast, to the extent that a 10% reduction in total system net primary productivity may soon be affected. This would represent the loss of energy from the equivalent of approximately fifteen 1,000-megawatt reactors. It is important to consider factors such as this in making decisions as to the relaxation of air-emission standards for fossil fuel plants, automobiles, etc. Viewed in energy terms, both the decrease in natural system primary productivity on one hand and the increase in energy produced for developed systems by the burning of fossil fuels (especially high-sulfur coal) on the other must be weighed against each other in a carefully calculated cost-benefit analysis.

Studies of such interactions between natural and developed systems (as indicated by the double arrow in Figure 5) are the subjects of studies being initiated in a proposed network of National Environmental Research Parks (NERPS). These areas include within their acreage and study domain components of *both* interacting *natural and developed systems*. In this way, they differ significantly and conceptually from National Parks such as Glacier, Yellowstone, or Yosemite National Parks. The latter areas include only elements of natural systems. The NERPS, on the other hand, include both natural and developed system elements. It is important to emphasize, however, that neither the natural nor the developed systems themselves are the actual subjects of NERP studies. It is, rather, the "double-arrow," signifying natural/developed system interaction, which is of prime concern to studies in such areas.

Activities within a NERP program may be grouped into three gen-

eral catergories: *(1) Environmental assessment* must be undertaken in order to understand the nature and extent of environmental impacts which are presently occurring in the area as well as to obtain a basic understanding of the structure and the function of both the natural and developed ecological systems on hand. This would be realized by a basic "boxes and arrows" type of study. *(2) Environmental prediction* must then follow the assessment process so that the consequences of alternate forms of energy production or other environmentally-important activity may be determined in advance. Of prime importance to such predictive studies is the establishment of mathematically and statistically reliable models which should not only be testable under field conditions but which should be realistic in terms of both their mathematical and biological/ecological properties. *(3) Environmental demonstration* must then occur so that there is an informing of all segments of our society to ensure that there will be intelligent input from all quarters in decision-making processes. This is especially true concerning decisions which must be made in the area of land-use planning. Such environmental demonstration and "public extension" should run the gamut from published research appearing in professional scientific journals through popular newspaper and magazines articles, lectures to technical and lay audiences and specialized briefings of groups having particular concerns or needs to understand environmental impact processes.

The Atomic Energy Commission's Savannah River Plant which is located near Aiken, South Carolina, was recently designated as the nation's first National Research Park. The on-going program at this site serves as a good example of a typical NERP program. The Savannah River Plant (SRP) area was closed to the public in 1952, thereby establishing an area of approximately 300 square miles as a production and research facility for the Atomic Energy Commission. Scattered throughout this area are a number of atomic production reactors. The liquid effluents from these reactors (which are larger in size and environmental impact than typical electric power generating reactors) enter a number of on-site natural stream water courses of the SRP. The effluents from these production facilities contain certain amounts of radionuclide wastes and heated water. The streams carry this heat and radionuclide burden in a generally southerly direction across the SRP area, eventually entering the Savannah River and passing downstream to the Atlantic Ocean. Before entering the Savannah River proper, however, these stream water courses pass through an area of approximately 30 square miles of cypress swamp. Cypress swamps are, to be sure, a "rare and endangered" type of ecosystem in most parts of the southeastern United States. The Audubon Society and other conservation-minded

groups have been devoting great efforts to preserving those few undisturbed cypress swamps still in existence, such as Cork Screw Swamp in the Everglades and Three-Hole Swamp in South Carolina. Until now, there have been no good *economic* reasons to argue for the preservation of such natural swamp ecosystems. The reasoning for swamp preservation and conservation has, until now, been largely moral and aesthetic in nature. Now, however, studies at the Savannah River NERP are beginning to suggest that the on-site cypress swamp of the SRP has patiently served over the past 20 or so years, *at no cost* to the AEC, as a giant heat-exchanger and radionuclide filter. The stream effluents entering this swamp are apparently cleansed of all significant radionuclide contaminants and excess heat, before being passed on downstream to the Savannah River itself.

In this swamp/filter heat exchanger system there are all of the elements for a classical NERP study. The swamp itself represents a natural system, running on sunlight energy-input alone, with no overhead maintenance costs to man. The production reactor complex upstream which produces the burden of radionuclide contaminants and heat acts as an element of a developed system and their interaction in the swamp area itself epitomizes the "double-arrow" of a NERP study, as diagrammed in Figure 5. Several years ago the Atomic Energy Commission contracted with the Institute of Ecology at the University of Georgia to begin to conduct studies of the cycling processes of radionuclide contaminants and the impact of these contaminants and heat upon this swamp ecosystem. The study was designed to answer the question of how this swamp has been able to act as a radionuclide filter and heat exchanger for the AEC. Even more importantly, however, the study was designed to ask what damage such activity has done to the swamp and its various inhabitants and what the consequences would be of continuing to expose the swamp to such impacts. In other words, it became important to know how long the swamp could continue to be expected to play this role of a no-cost radionuclide filter and heat exchanger.

The procedure used by the University of Georgia scientists in this swamp study were basically a "boxes and arrows" road-mapping of the ecosystem with respect to several important radionuclides. In conducting these studies, many representatives of the different trophic levels of the swamp's food webs were studied. These included studies of soil and sediments, insects, plants, trees and aquatic vegetation grazing herbivores such as grasshoppers, mice and deer and predators such as foxes, bobcats, snakes and alligators. Finally, predictive mathematical models, particularly those describing frequency distributions, were used in an attempt to place all of these studies into a common "boxes and arrows" conceptual framework.

Although far from complete, the results of these studies are already becoming available in the form of symposia and published scientific manuscripts.

The swamp studies of the Savannah River Plant simply illustrate a NERP study program which can easily be duplicated in concept in many other areas of the United States. The National Reactor Testing Station in Idaho, for example, is another large piece of AEC-controlled land in which NERP study programs could easily be initiated. This area which is located in southeastern Idaho contains a number of experimental reactors which may interact in various ways with the natural sagebrush ecosystems of this site. Certain portions of the 900 square miles of this Idaho habitat are also exposed to grazing pressure by domestic cattle and sheep. These domestic livestock represent an extension of a "developed" livestock-industry ecosystem component. They interact in many important ways with the natural ecosystems of the area and their inhabitants. For example, herbicidal sprayings and chainings to control sagebrush and encourage the growth of grass for grazing drastically alter the natural ecosystems present on the area. Predator control by the poisoning or shooting of coyotes also represents a "double-arrow" interaction between man's developed and natural ecosystem components. These and other such NERP study programs are presently being considered for future study at this site. Other AEC sites at which similar NERP study programs could be initiated include the Hanford Reservation in Washington State, the Nevada Test Site and the Los Alamos Proving Grounds area in New Mexico.

In conclusion, the NERP study programs offer an opportunity, possibly for the first time, to conceptually relate the environmental impacts and activities of the developed systems created by man's society and technology with the natural ecosystems which may adjoin and be interspersed with such developed areas. As suggested by this presentation, energy considerations might easily form an important point of departure from which such studies may be initiated. In the final analysis, however, it should be those basic ecological principles relating to the gradient in levels of complexity of organization, the concepts of systems which act as single structurally and functionally integrated units at all levels of organization and the "boxes and arrows" sub-system component analysis procedure which will allow these studies to be conducted in a meaningful and relevant fashion.

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STATEMENT OF DR. JAMES L. LIVERMAN, ASSISTANT ADMINISTRATOR FOR ENVIRONMENT AND SAFETY, U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

Dr. LIVERMAN. Mr. Chairman, it is a pleasure for me to be back before the committee. As you know, I face you quite often and it is always a pleasure to come back.

Today, however, I feel particularly privileged to be here because the problem that you are discussing is one that is very near and dear to my own professional heart—namely, the preservation of large land areas that can be used on a continuing basis for environmental R. & D. Basic studies, as Dr. Brisbin has outlined beautifully, of developed systems and undisturbed ecosystems, should help us to better understand what the broad impacts of man's activities across a much broader landscape would be.

My own personal view of these National Environmental Research Parks calls for a relatively small investment in terms of dollars and effort. With the proper orchestration—which seems to be the general intent of H.R. 6379—of these resources we can certainly get a very great payoff in terms of understanding natural ecosystems and how they may be impacted by various things. At the same time that we are getting those things out of the environment that we need, we can also maintain the quality of the environment.

Dr. Brisbin has alluded to it and my own feeling is that ERDA's principal contribution in this subject of natural areas derives from our National Environmental Research Parks program which arose from a rather small number of fortuitous decisions made early in World War II. It became obvious that if the United States and its allies were to come out on top in World War II, we should make nuclear weapons. In order to do this, one needed areas that were secure and remote for safety and for national security reasons. These areas had to have an ample supply of water and they needed to be able to be guarded with the least possible inconvenience to people working and living in the areas.

Today we call these facilities national laboratories, test sites, or what have you. Names such as Oak Ridge, Hanford, Brookhaven, Los Alamos, and Argonne, that are everyday words now, were originally not conceived of as places where you could do environmental research. But as we proceeded during early World War II with the development of nuclear energy, it became very clear that we had to set up mechanisms by which we could track radioactive fallout and releases from our own production plants as they entered the environment and the food pathways to man. All of this came about as happenstance without any great and grand design behind it. So, fortuitously, then, in the mid-50's we found ourselves with large land areas with restricted access, a variety of climates, scattered over the Nation. These included forests, grasslands, and other vegetation types and provided us with the capability to run long-term, controlled experiments without any, except the most essential interruptions. Even these interruptions could be largely controlled or if not controlled, the areas could be studied for any impact on them. This is a very important point. From studies of the impact these interruptions one could begin to see what

steps were needed in the future to prevent further degradations from taking place.

Mr. BROWN. May I ask you, Dr. Liverman, whether at this early date the terms ecology and ecologists were in very broad use?

Dr. LIVERMAN. Well, it was a pretty academic subject.

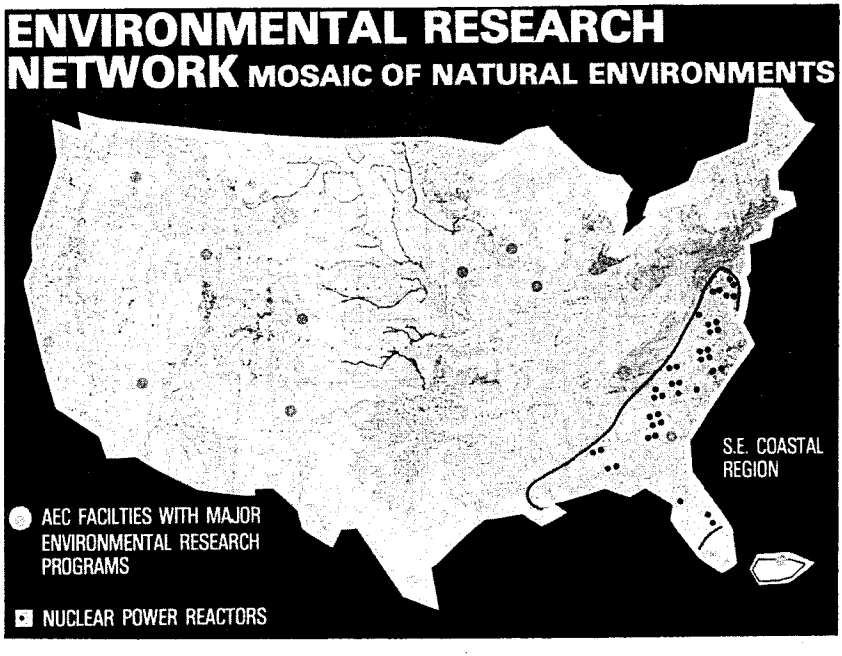
Mr. BROWN. You actually, knowingly or unknowingly, were initiating some of the earliest research in ecological sciences, I presume.

Dr. LIVERMAN. Yes; that is correct. I was going to bring it up a little bit later in my statement. But I think now is a good time.

I think we owe much credit for what we now have in NERP's to a few far-sighted people like Dr. Stanley Auerbach, of the Oak Ridge National Laboratory, and Dr. Bill Osburn, of my staff, both of whom are here today and to Dr. Eugene Odum, University of Georgia. They saw the need for large land masses with controlled access to trace radioactive elements through the food pathways to man as a basis for regulatory standards. Dr. Odum, one of the country's leading ecologists, was instrumental in developing a research program at the Savanah River Plant which you have just heard about. A few other farsighted people, for instance John Wolfe, now deceased, who headed AEC's first environmental program, could see that these sites offered a unique opportunity for study if seized upon and vigorously pursued.

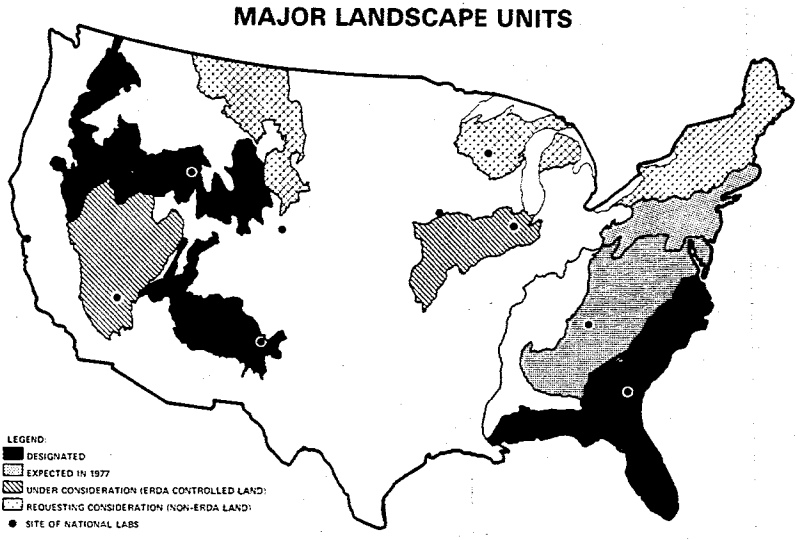
So, yes, what you say is largely correct as it was somewhat by chance. However, we owe much to the influence of the people I have mentioned and many others who have led us in that direction.

Another important point is that there are an enormous number of different kinds of ecosystems scattered over the face of the Nation (slide No. 1). It was fortuitous again that in siting our facilities on



SLIDE 1

the necessarily large land masses with adequate water supplies we had the beginning of a systematic network. You see Brookhaven National Laboratory up on Long Island. You see the Savannah River Plant down in the southeast coastal region. You see the Oak Ridge National Laboratory at the foot of the Applachian Mountains. You see sites in the Midwest, some in the Rocky Mountain States, and in Idaho, Washington, California, Nevada, New Merico; each of them in quite different climates.



SLIDE 2

Slide 2 illustrates the point that I wish to make. Namely, that it just happens that these facilities end up being in almost the center, or, if not the center, certainly well within the regions that represent large ecosystems. The one at Savannah River, for instance, which is fairly large, is quite representative of much of the southeastern and gulf coast coastal plain area. So the results which you obtain from studies at the Savannah River Plant, with proper ground proofing or confirmation, are probably extrapolatable to most of that region. This is a key point. If you can then run experiments at a given site, studying effects of impacts before you have to impose impacts on a whole region you begin to be able to anticipate what is going to happen and may take ameliorative steps.

So we found ourselves, then, in a position to begin to do the kind of thing I have just talked about. Namely, in a limited area, we can

begin to run experiments that might be extrapolatable to broader areas.

It is interesting how the concept of National Environmental Research Parks has begun to be multiplied and utilized by others. Only in yesterday's mail, for instance, I had a letter from the vice president of PEPCO. Interestingly enough, they bought 1,400 acres at Douglas Point a number of years ago with the intent of establishing a nuclear powerplant there. Because of many recent events, which is a totally different discussion, the decision has been made that they will defer the construction of that plant until some time in the future.

What do they find themselves with? They find themselves having paid for 5 years of baseline studies carried out by the universities in the region. They were beginning to wrap around the problem rather well and now, all of a sudden, they decided that they are going to defer for sometime the construction of that nuclear plant. As most profit-making institutions, they have great difficult believing that they should continue to run that ecological reserve, as it were, until such time as the company decides to build a plant, but under the concept we have, they are getting that baseline information. They are looking at the natural ecosystems there, in a broad sense, so that they can prevent hopefully the kind of thing that happened at Indian Point II. Yet the question was: Dr. Liverman, can you help us in any way with your National Environmental Research Park concept? Is there any way that you can continue to help us sustain this effort?

I think this is a question that is repeated many times over: That the Nation somehow needs to deal with because here is an organization willing to devote and maintain this land and to keep it restricted. They welcome within their fences studies by anyone who wants to do studies there if they can bring their own money.

So, I think that as the committee wrestles with this problem of land areas, this may be an area to which you would like to give some kind of consideration. I do not know exactly how one deals with it.

Mr. BROWN. Well, does this relate at all to the concept, that has surfaced on many occasions, of the prior acquisition and analysis of nuclear plant sites by some agency of the Federal Government in order to shortcut the ultimate process of licensing and so on?

Dr. LIVERMAN. I think it bears directly on that question. The country and agencies of the Government have not quite faced up to how one achieves the selection of sites, carries out the baseline studies that can help one to come to the decision, either on the part of the State or the Federal Government, as to what are, in a given State or given area, the sites that really are best suited for commercial development whether it be powerplants or something else. Again, I do not think the problem really has been thought through fully as to see how we achieve that. I think the goal is clear. Most people would support that. But, how you go from where we are to do it with private enterprise and the Federal Government both being involved is a pretty open question.

It is interesting that Jim Schlesinger, who was at that time the chairman of the Atomic Energy Commission and is now the Secretary-

designate of the soon-to-be Department of Energy, is the man who designated the first National Environmental Research Park at Savannah River. Because of speeches he made, which often make policy, the Idaho site was designated as a National Environmental Research Park. I am not sure how many people in town are aware that Jim Schlesinger had the foresight to do that.

Mr. BROWN. He wanted some place to do his bird watching. [Laughter.]

Dr. LIVERMAN. Perhaps. Let's go to slide No. 3.

RESEARCH RESULTS ALLOW

1. ASSESSMENT of Environmental Impacts of an Energy Activity

2. PREDICTION of Environmental Impacts from Postulated Energy Activity

3. DEMONSTRATION to Public of Environmental Costs

SLIDE 3

Let us move ahead. Dr. Swinebroad, who is in the audience here with us, is a favorite bird watching colleague of Dr. Scheslinger, so maybe he could say more than I can.

You see here an indication of the many sites that are under ERDA control, some of which have been designated formally as National Environmental Research Parks.

The second column shows their sizes in thousands of acres: Savannah River is about 200,000; the Idaho site about 600,000; the Hanford site about 400,000; the Oak Ridge site, which has not yet been designated, about 37,000; Nevada test site, three-fourths of a million acres.

The third column indicates the general kinds of ecosystems that exist there. For instance, Los Alamos has a juniper piñon vegetation type. The Oak Ridge site is fairly typical of an Appalachian forest, whether you are in Tennessee or in Pennsylvania. It covers a very broad spectrum of ecosystems types and means that one can establish or there already exist a wide diversity of research programs.

1. RECOMMENDATION 8*

COMPLETE A NATIONAL SYSTEM OF ECOLOGICAL RESEARCH AREAS TO:

a. PROVIDE SITES FOR MANIPULATED EXPERIMENTS

b. MANAGEMENT TESTING

c. OBSERVATIONS OF THE RESULT OF HUMAN IMPACT

*THE ROLE OF ECOLOGY IN THE FEDERAL GOVERNMENT. THIS IS THE ONLY REPORT ASSESSING THE EXTENT AND STATUS OF ECOLOGICAL RESEARCH BEING CARRIED OUT BY FEDERAL AGENCIES.

SLIDE 4

The next slide—slide No. 4—indicates some additional sites which we have and I would like to point out one or two things. The ERDA sponsored Puerto Rico Center controls an area typical of tropical rain forests. They have come to us and asked if we are interested in establishing an environmental research park there.

Dr. Brisbin mentioned Cape Thompson, which has about 100,000 acres typical of arctic tundra. The Natives own part of it. It has already had, perhaps, as large a baseline study done on it as any place in the Arctic. We are working with the Department of the Interior and the Navy to maintain some degree of control over that region in order to continue those baseline studies because of the enormous resources and the energy potentials that exist in Alaska. We believe that we can obtain a better understanding of how we need to protect the environment through work performed at that site.

I could continue to go on through others.

I would like to make one more point, however. If I go back to slide No. 2 which shows the distribution I can point out that there is a great void in which there are no National Environmental Research Parks and not all the sites shown constitute National Environmental Rsearch Parks. I would like to draw my hand down through the middle of that map in the central part of the country, where, as far as ERDA is concerned, we have no activities that really contribute in a major way to understanding that area to the country which represents much of our agriculturally vigorous areas.

Mr. BROWN. Dr. Liverman, why is Hanford not designated on that chart?

Dr. LIVERMAN. Well, it should be.

FROM THE AUDIENCE. It is, it is just not clear.

Dr. LIVERMAN. I think it is the black dot down near the bottom of the State of Washington.

Mr. BROWN. My eyes are not all that good.

Dr. LIVERMAN. The point I wish to make with this slide is that ERDA, certainly, in no way believes that we are the protectors of the Nation's total landscape. The Departments of Interior and Agriculture, and many others have many holdings. But I think if one begins to put together what you are trying to do here—namely: Where are those areas? What do they represent? Are they typical of most of the United States? It would be interesting to know if one superimposed on that map all of the different kinds of ecosystems that are now included in anything resembling environmental research parks, we could, perhaps come to a far better understanding of what studies we need to do on those sites with controlled access to give us a better understanding of environmental impact across the Nation.

2. RECOMMENDATION 8

(Cont.)

AT PRESENT A SYSTEM OF NATIONAL ENVIRONMENTAL RESEARCH PARKS HAS BEEN ESTABLISHED ON CERTAIN FEDERALLY OPERATED FACILITIES. IT IS RECOMMENDED THAT THESE FORM THE BASIS FOR THE NATIONAL SYSTEM OF ECOLOGICAL RESEARCH AREAS.

SLIDE 5

Slide No. 5 points out (1) that environmental research parks give us an ability to assess environmental impacts of energy activity and (2) the ability, hopefully, to predict in ecosystems that are quite similar what the impacts are likely to be.

The third important point, which Dr. Brisbin did not mention but which I think is rather obvious if you think about it, is that one can demonstrate with real live things what the impact of proper management of the environment can be even in those developed ecosystems which Dr. Brisbin discussed.

NATIONAL ENVIRONMENTAL RESEARCH PARK SITES UNDER CONSIDERATION

LOCATION	SIZE ACRES, 1,000's	VEGETATION TYPE (KUCHLER)	RESEARCH PROGRAMS
SAVANNAH RIVER PLANT* SOUTH CAROLINA	200	MIXED HARDWOODS AND FLOODPLAIN FORESTS	MINERAL CYCLING; THERMAL EFFECTS
IDAHO NATIONAL ENGINEERING LABORATORY – IDAHO**	572	ARID SAGEBRUSH SHRUB	RADIONUCLIDE MOVEMENT IN TERRESTRIAL SYSTEMS
ARGONNE NATIONAL LABORATORY ILLINOIS	3.7	TALL GRASS PRAIRIE AND FOREST EDGE	WATER MOVEMENT; THERMAL EFFECTS; NUTRIENT CYCLING
BATAVIA, ILLINOIS (NATIONAL ACCELERATOR LAB)	6.8	TALL GRASS PRAIRIE AND DECIDUOUS FORESTS	PRAIRIE RESTORATION
BROOKHAVEN NATIONAL LABORATORY NEW YORK	5	NORTHEAST OAK AND PINE FOREST	EFFECTS OF RADIATION; TERRESTRIAL AND AQUATIC ECOLOGY; NUTRIENT CYCLING
LAWRENCE LIVERMORE LABORATORY CALIFORNIA	1	ANNUAL GRASSLAND AND CHAPARRAL	RADIOECOLOGY OF AQUATIC ECOSYSTEMS; AIR POLLUTION EFFECTS ON VEGETATION
LOS ALAMOS SCIENTIFIC LABORATORY*** NEW MEXICO	27	JUNIPER AND PINYON FOREST	RADIOECOLOGICAL STUDIES OF LIQUID WASTE DISCHARGE AREAS
NEVADA TEST SITE NAVADA	850	DESERT SHRUB-CREOSOTE BUSH AND GREAT BASIN SAGEBRUSH	FATE & EFFECTS OF RADIONUCLIDES; NUTRIENT CYCLING
OAK RIDGE NATIONAL LABORATORY TENNESSEE	37.5	APPALACHIAN OAK FOREST	AQUATIC & TERRESTRIAL ECOLOGY; IBP ECOSYSTEM STUDIES
PACIFIC NORTHWEST LABORATORY*** WASHINGTON	365	SAGEBRUSH STEPPE AND FESCUE GRASSLAND	TERRESTRIAL ECOLOGY; THERMAL EFFECTS; BIOGEOCHEMICAL CYCLING

*Designated April 1972
**Designated January 1975
***Designated 1976

SLIDE 6

NATIONAL ENVIRONMENTAL RESEARCH PARK SITES UNDER CONSIDERATION (Cont.)

LOCATION	SIZE ACRES, 1000'S	VEGETATION TYPE (KUCHLER)	RESEARCH PROGRAMS
PANTEX AMARILLO, TEXAS	10.2	GRAMA-BUFFALO GRASS GRASSLANDS	IBP ECOSYSTEM STUDIES
ROCKY FLATS COLORADO	2	SHORT GRASS PRAIRIE MONTANE GRASSLAND	RADIONUCLIDE MOVEMENT IN TERRESTRIAL AND AQUATIC ECOSYSTEMS
	LAND NOT UNDER ERDA CONTROL, BUT UPON WHICH ERDA HAS OR IS SUPPORTING EXTENSIVE ECOLOGICAL RESEARCH		
PUERTO RICO NUCLEAR CENTER PUERTO RICO (IN COOPERATION WITH THE FOREST SERVICE)	<1	TROPICAL RAIN FOREST MARINE-ESTUARINE	ECOLOGY OF MARINE SYSTEMS; RADIATION EFFECTS ON TROPICAL FORESTS
AMCHITKA, ALASKA (IN COOPERATION WITH THE U.S. FISH & WILDLIFE SERVICE)	75	MARITIME ARCTIC TUNDRA	TOTAL ECOSYSTEM ANALYSIS; BASELINE STUDIES STRESSING SUCCESSION OR RECOVERY OF ECOSYSTEMS
CAPE THOMPSON ALASKA (IN COOPERATION WITH THE U.S. NAVY)	100	ARCTIC TUNDRA	TOTAL ECOSYSTEM ANALYSIS; BASELINE STUDIES
RHINELANDER, WISCONSIN (IN COOPERATION WITH THE U.S. FOREST SERVICE)	1.4	NORTHERN HARDWOODS	TERRESTRIAL RADIOECOLOGY
ENIWETOK	<1	PACIFIC ATOLL	PRE- AND POST-NUCLEAR TESTING STUDIES
POWDER RIVER BASIN U. OF WYO.	?	INQUIRES	
		GRAMA-NEEDLE GRASS - WHEATGRASS GRASSLAND	
T. V. A. REGION FEBRUARY 3, 1976		MIXED-OAK-HICKORY DECIDUOUS FORESTS	
PUERTO RICO TRUST	5	TERRESTRIAL & ESTUARINE ECOSYSTEMS	

SLIDE 7

There was a report put out not long ago, entitled "The Role of Ecology in the Federal Government" which is really the only report that assesses the extent and status of ecological research being carried out by the Federal agencies. I take it as a compliment to ERDA because it discusses—slides Nos. 6 and 7—the need for a national system of ecological research areas. It says that our National Environmental Research Parks should be used as an example of the kind of thing that needs to be created in order to build for the Nation a system of ecological research areas in which one can run controlled experiments of one kind or another.

I have no more slides and I will finish very quickly.

I do not think you have asked us to testify and concern ourselves very much with the particular piece of legislation. My statement submitted for the record goes into some detail to give you a feeling for the size of acreage that needs to be set aside. Obviously it can vary, but I would point to the slide that Dr. Brisbin showed of the Savannah River site, in which you need an area large enough to have controlled sites where you let nature develop as nature will and you do not add any stresses to that particular area. But you need an identical site or period in the same general region for comparison where you do, in fact, impose upon that ecosystem various kinds of insults arising from man's endeavors. It will depend, somewhat, upon the particular nature of the experiments and on the vigor of the ecosystem in which things happen. One could set aside as much as a million or a million and one-half acres which could be used for a given set of experiments. I think that by judicious design of experiments, by coordination of experiments in the various ecosystems, one can sharpen up and define and more nearly limit the amount of land that needs to be set aside for such things.

The administration has not yet taken a position on H.R. 6379. Clearly, as you mentioned in your opening comments, this is a matter the administration is thinking about, about land areas. I think there is one important point from my own background and experience that the committee could well keep in mind, and that is to cast a watchful eye upon what we in the administration come up with, to cast a watchful eye on seeing that there is an ability to force the total compliance with NEPA as these land masses may be diverted to other uses. Also, remember the important points that Dr. Brisbin makes—that you do not learn about how fragile or how vigorous—that is not quite the word—resilient the environment is without testing it at some time. We believe then that our sites—National Environmental Research Parks—offer the opportunity for two types of study. One is on undisturbed or control areas and the other in areas wherein man deliberately or inadvertently impacts the environment.

Protecting these sites that are set aside for the R. & D. is just as important as farming or other kinds of activities. One needs some mechanism by which to achieve that. Perhaps NEPA is the way, if properly enforced.

With those comments, Mr. Chairman, I will close and am open for any questions you may have.

Mr. BROWN. Thank you very much, Dr. Liverman.

Dr. Liverman, is it really possible in most parts of the United States to have an ecological research site that is not impacted substantially by man's uncontrolled activities? I am thinking of the maps, for example, which show the prevalence of acid rain covering almost the entire Eastern United States.

Dr. LIVERMAN. Well, the problem that you raise is obviously a serious problem for the development of control areas. One thing that can be said is that you cannot control the impact of that acid rain unless you get all of the SO_x and related things. Acid rain is not the only thing that is going to impact those areas. So using acid rain on two sites that are equivalent, you can bring in shopping centers, you can build highways, you can bring in farming, you can superimpose upon that not quite a clean baseline, but certainly a baseline, other insults that may arise. That is the best we have in most places. So one has to live with what is out there, but try to then superimpose upon those controlled experiments within limits to try to determine what additional impacts there may be. It is not clear that acid rain is always bad. It is certainly bad for buildings. If you have a shortage of sulfate in the soil, it is not totally clear then that it is necessarily bad, but we simply do not know.

Mr. BROWN. Well, in southern California, which is my own area and a particularly hazardous one from the air standpoint, pine forests are being devastated by ozone 100 miles from the main center of population. In fact, the University of California at Riverside has just received an additional $250,000 to study this phenomenon, which should be a part of an environmental research park project. I do not think we have any environmental research parks in southern California, but we are talking about national forests and in some cases wilderness areas. It seems more and more difficult as we contemplate the need to expand energy-producing facilities in new areas, to keep from impacting at least air quality over large parts of the United States, and the vegetation and animal life and so on.

Dr. LIVERMAN. May I make another comment related to your specific comment? It seemed to me as I drew my hand down through the middle of that map, that as the Nation begins to allow its national forest lands to be utilized for mining, recovery of mineral resources and biomass production, it is imperative to establish simultaneously a research program. I think it rests right in the lap of this committee, as a matter of fact, to try to insure that there is constituted at the same time we turn over millions of acres for the extraction of energy resources something that resembles a National Environmental Research Park effort to begin to examine what the impact may be. Because we are going to be mining coal (unless the CO_2 becomes a problem) for many, many years. Let us begin to look at all aspects of the question more vigorously than we have before to do that.

My own feeling is that this kind of R. & D. must march hand-in-hand with the implementation of mining. We must examine the environmental impact of mining and resource recovery. It simply is not taken into account in the usual course of events.

Mr. BROWN. Dr. Liverman, you and Dr. Brisbin have outlined the development of the environmental research parks beginning with

World War II as a sort of a casual or almost accidental response to the development of a new energy source. I am sure, a feeling was involved in it that we were ignorant of the environmental impact of this new energy source and that we needed to do this kind of research to fully assure the people of the country that we could live with the results. Well, this subcommittee has been having hearings on the environmental consequences of the President's energy plan, particularly on its provisions for increased coal use. Testimony on human risk, part of which is environmental and part of which is accident-related, indicated that the coal cycle is somewhere around 200 to 500 times as hazardous as the nuclear fuel cycle.

Is it possible that under these circumstances we decided almost accidentally to develop these parks because of the development of a nuclear fuel cycle, all the while knowing what we are in for in terms of additional coal development, yet not planning on an even broader scale for some coal-oriented research effort? What I am trying to state rather imperfectly is, shouldn't this knowledge of coal impacts lead to the further development of the concept of research parks?

Dr. LIVERMAN. It certainly should and again I find myself taking my hat off to Dr. Brisbin, but on that Savannah River site there must be some 10 or 15 coal-fired units, and the group there has been addressing the environmental impact immediately around those sites.

But to answer your question directly—I think it is imperative to do so. I think that our sites in ERDA can be utilized somewhat, but we do not exert control over a large mass of the land and in my view it falls to the responsibility of somebody—I do not know whether that is ERDA or the new DOE or Agriculture or Interior or all of us jointly, to come up with a concept of how we do the kind of thing you are examining here fore the alternative energy sources other than nuclear.

Mr. BROWN. If the Congress should succeed in passing a major synthetic fuel bill as has been proposed several times before, it seems to me that as a logical followup we should include in it components which would reflect this research park approach as we move into shale and high-Btu gasification, coal liquefaction—the whole gambit of using this fossil fuel. We ought to do at least as much as the AEC did on the nuclear program.

Dr. LIVERMAN. I find myself on a continuing basis commenting on many bills that enter the hopper in the Congress and, almost without exception, I find that I am writing into each one of those a need to address the environmental question. I think the price of doing this is constant vigilance on everybody's part because we have to get the energy and we do not seem to learn the environmental consideration lesson very well.

Mr. BROWN. Yes.

Mr. Spensley?

Mr. SPENSLEY. Dr. Liverman, is it not true that the NERP sites might disappear tomorrow with a swipe of the signature of the Administrator of ERDA or a decision of the Secretary?

Dr. LIVERMAN. Well, it would be over a lot of objection on my part.

Mr. SPENSLEY. The point is that NERP's have been established administratively and could be abolished with a decision of the Administrator or the new Secretary.

Dr. LIVERMAN. That is correct.

Mr. SPENSLEY. Do you think there is any prudence in looking at any protective legislation for these sites? Do you think that your agency, which started NERPs, has done quite well with them and has expanded them, wants Congress mingling in those affairs now?

Dr. LIVERMAN. Well, there is as you are well aware from the general flow of your question that these large land areas that belong to the Federal Government are constantly subject to encroachment by farmers, by ranchers, by people who want to harvest forests, and there are not in existence very many rules or regulations that prevent that encroachment. My life would be simpler if some mechanism existed. Perhaps the need for protecting these lands will be driven home by Charlie Warren of CEQ. GSA surveys us. GAO surveys us. Every new administration surveys us. Every time it is up for reconsideration. Perhaps it is worthwhile and important to say that ability to do environmental R. & D. on natural areas is an important national goal also, and, therefore, before you give way, destroy, write off these things, you have to take into account the following considerations. That is entirely possible.

Mr. SPENSLEY. Let me ask just one more question.

Is there a mechanism in the administrative procedures of ERDA that when excess land becomes available or surplus, it is reviewed for use as a potential NERP site before it is turned over to GSA for sale?

Dr. LIVERMAN. I think the answer is no, but I will check it.[1]

Mr. SPENSLEY. OK.

Mr. BROWN. Thank you, Dr. Liverman, for your testimony.

Dr. LIVERMAN. Thank you.

[The prepared statement of Dr. Liverman follows:]

[1] The correct answer is that due largely to urging by the ERDA representative, the charter for the Federal Committee on Ecological Reserves contains a provision whereby Federal lands which the GSA declares excess are systematically reviewed for potential environmental research value.

STATEMENT FOR THE RECORD

OF

DR. JAMES L. LIVERMAN

ASSISTANT ADMINISTRATOR FOR ENVIRONMENT AND SAFETY
U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON THE ENVIRONMENT AND THE ATMOSPHERE

JULY 28, 1977

Mr. Chairman and Members of the Subcommittee--

I appreciate the opportunity to appear here to discuss with the Subcommittee ERDA's National Environmental Research Parks Program.

A National Environmental Research Park (NERP) is an outdoor laboratory dedicated to studying the impact of man's activities on the environment so that ERDA's and the Nation's environmental goals may be achieved. Not only are NERPs places to conduct research but a cadre of environmental researchers are an integral part of the program. The core of my presentation may be found in the NERP charter and the associated program directives. The charter outlines research objectives and the program directives represent a research plan or guide whereby ERDA and national environmental goals may be achieved. Thus NERP's if expanded into a full network offer a mechanism whereby the spirit of NEPA may be attained. Ultimately, the NERPs should include sites representative of all ecosystems (in every stage of succession and recovery from stress) within each physiographic region of the United States.

ERDA emphasis focuses on activities related to energy resource development; efforts will be continued to insure that appropriate sites are reserved for research needed to determine the range of impacts associated with each stage of alternative energy developments. Thus, within each NERP, or NERP satellite, there will be protected natural areas (experimental controls or research reference areas) and examples of such man-altered systems as nuclear and fossil fuel powerplants, heated ponds and streams, cultivated fields, tree plantations, grazed land, and land disturbed by construction activities. With the exception of certain restricted areas, land within a NERP may be made available for environmental research on a permit basis. The participation of

researchers with outside funding is invited.

The research program conducted at each NERP will be unique, but all programs will address three general objectives: (1) to develop methods to continuously monitor and assess the environmental impact of man's activities; and (2) to develop methods to estimate and predict the environmental response to proposed and ongoing activities to minimize adverse impacts; and (3) to serve as demonstration areas to fully inform the public of the various environmental and land use options open to them.

Most ecological studies require, first, a common group of factors or conditions to be determined with each experiment such as, soil fraction, pH, nutrient levels, and vegetation type. Second, for proper interpretation of the response of organisms to environmental stimuli, the environmental regime under which the experiment takes place needs to be measured. Third, one needs to know whether or not the environmental pattern for that year is typical, or how atypical. Hence, the experimental year environment must be compared to that of other years; the greater the number of years the more reliable the predictions will be. Thus, experiments superimposed upon other studies can be carried out with much less expense and their results become more precise. Additionally, previous experiments may be opened for re-examination. Hence, since ERDA is able to provide foundation data, others may capitalize upon it with benefit to all.

National Environmental Research Parks have been established at the Savannah River Plant, South Carolina (1972); the Idaho National Engineering Laboratory near Idaho Falls, Idaho (1975); the Los Alamos Scientific Laboratory in New Mexico (1976); and the Hanford Reservation near Richland, Washington (1976). Designation of the Oak Ridge site and the Puerto Rico Center for Energy and Environment Research as NERP's is expected in 1977. Several other major ERDA sites and some areas managed by other Government agencies or private groups are currently being considered for inclusion in a national NERP network.

Now to address specifically the two questions on which you have requested information: How much land will be needed for environmental research? Will legislation be needed to protect these research lands?

First, as to the amount of land needed, ecology has not reached a stage of sophistication sufficient enough to give us a quantitative estimate. Let me pursue this for a moment. You are all familiar with the story of the lad who invented chess. As payment he requested one grain of wheat for the first of the 64 chess squares and double the number of grains for each of the remaining squares. The emperor - not making the needed calculation - offered a "super generous" reward of several bushels of grain. At the lad's insistence, a calculation was made and the magnitude of the payment was soon apparent.

Most people will readily admit that we need to have land on which to conduct environment research. It is vital to developing information to resolve pressing problems. And like the emperor most people are willing to set aside, "generously," a few acres. Like the chess inventor, we should force a calculation. Let us examine the various considerations.

1. For statistical reliability, at least 10 replications of nearly any experiment are needed.

2. At least three treatments are required plus a control. One treatment should be at a level of upper tolerance, one at a lower limit of response and a third in between.

3. Size of each experimented plot must be determined. For small mammals, Golley of the University of Georgia calculates 2-10 acres. Also, a minimal area for the community should be considered. Minimal area means large enough to contain all normal components (plants and animals), normal populations, normal functions, activities, and behavior.

4. Another consideration is that in order to observe seasonal effects an experiment should be carried out for at least a year. In order to observe effects of extreme years, perhaps 10 years is a minimum.

5. Each experiment should be done at least twice.

6. Each stress experiment can be initiated during fall, winter, spring and summer (4 more variables) and results can be expected to differ.

7. The above applies to one stress only. When several stresses or interactions are considered, the permutations become almost infinite.

8. Each year, some 10 to 15 new materials are added to our foods or, in some manner, introduced into our environment.

9. A calculation goes as follows:

10 x 4 = 40 plots x 5 acres each - 200 acres x 2 (repeats) = 400 acres x 4 seasons initiated = 1600 acres x number of different ecosystems in U.S. region, say 100, = 160,000 (aquatic habitats

not included) x 10 new toxic materials introduced =

1,600,000.

Each year we would tie up for 10 years over 1 million acres. For this research to be truly representative of the region in which the experiment is performed, one would also need to perform a number of additional land-consuming experiments to ascertain whether or not the results could be extrapolated over the entire region.

10. One should carry experiments through a complete succession cycle. In the South, this may require 10 to 50 years, whereas in arctic regions several hundred years are required.

One way to circumvent such large land use is by a judicious selection of experiments. In chemistry, by following certain procedures, an unknown may be examined for many different things. However, if one follows an improper sequence the sample is destroyed after one trial. Ecological experiments, too, should be carefully planned to avoid failures.

Simultaneously with planning experiments, we need to "design" our outdoor laboratory. Step 1 is for a group of scientists, land managers, and administrators to decide what kind of landscapes and communities are desirable in order to offer a maximum field research potential for a particular physiographic region and for its future. The questions to be considered are: What kinds of commities, how many stands (examples) of each and how many acres per stand, and how distributed in relation to soils, topography, and geology? What kind of management is needed to create and, in case of subclimax types, maintain each ecosystem or community? This first effort, defining the desired

mix of ecosystems, has to be based mainly upon the scientists' best judgment as to future needs. They must be pre-eminent in any planning of this type. This process of defining the land management objectives is extremely important. It is comparable to designing a laboratory only it is more difficult to correct mistakes. No outdoor laboratory blue prints are presently available.

In response to the second question regarding legislation needed to protect environmental research sites, we could discuss H.R. 35, H.R. 39, and H.R. 6286. But in my view, the most important is H.R. 6379: "To establish a non-profit center for long-term environmental research and other purposes." Although, to date, the administration has not formulated a position on the bill, this type of legislation will receive further consideration during administration deliberations on Government reorganization.

With proper planning and related funding, I believe ERDA's NERP program could serve as an example for other Federal agencies to follow. In fact, the interagency report, issued in 1975, "The Role of Ecology in the Federal Government" strongly recommended that other groups follow the NERP lead.

Mr. Chariman, this concludes my statement. I will be happy to answer any questions you might have.

Information from ERDA
Washington, D.C. 20545

FACT SHEET

NATIONAL ENVIRONMENTAL RESEARCH PARKS

National Environmental Research Parks are protected areas in which scientists can conduct long-term experiments to learn the impact of man's activities on the natural environment and on environments already altered by man such as abandoned farm fields and land that has been strip mined. Four Parks, totalling more than a million acres, have been established since 1972 when the first came into being. They are located on ERDA-owned land near Los Alamos, New Mexico; Richland, Washington; Idaho Falls, Idaho; and Aiken, South Carolina. The Parks co-exist with ERDA research and production facilities for which the land was originally purchased.

Each Park represents a specific environmental region and a variety of ecosystems which are typical of large areas of the United States. For each, there is already a substantial body of basic information on geology, wildlife, vegetation, aquatic systems and meteorology. These Parks, which are under the supervision of ERDA's Assistant Administrator for Environment and Safety, are available for research use by scientists from universities, private foundations and other state, local and federal agencies. They offer a unique national resource for understanding, and learning to control, man's effects on his environment and for advancing national environmental goals.

(MORE)

THE ORIGINAL CONCEPT

Ecological studies require controlled lands where instruments can remain undisturbed and the study areas are protected from intrusion by vehicles and casual visitors. Through historical circumstances, the Energy Research and Development Administration owns very large tracts of land in nearly all of the major environmental regions of the United States.

These areas were inherited from the Atomic Energy Commission. They were purchased in the 1940's and 50's as sites for nuclear research laboratories and production plants which require large buffer zones around them, both for security and for safety.

Proposals to turn large sections of these sites into National Environmental Research Parks were made by scientists at several AEC facilities as early as 1970. For example, scientists from the Savannah River Ecology Laboratory, which was operated for the AEC by the University of Georgia, proposed that those segments of the Savannah River (South Carolina) Plant site not being used intensely be set aside as reference ecological areas and for use as a protected outdoor laboratory. There, long term experiments could be conducted to test the effects of various chemicals, of construction and of agricultural activities. The concept was a logical outgrowth of the 1969 National Environmental Policy Act and of increasing concern for preserving representative land areas.

For 25-30 years, these nuclear sites had been protected from public intrusion. Large portions of them had been left in their natural state or were permitted to revert to a natural state from previous human uses which included town sites, cultivated fields and grazing lands. In addition, a substantial catalogue of information on the soil, ecology, hydrology, vegetation, wildlife and aquatic systems on the sites had been compiled as a result of years of environmental research and decades of environmental monitoring necessitated by the nuclear work.

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The Savannah River site was designated a National Research Park in 1972. In 1975, ERDA's Idaho National Engineering Laboratory site near Idaho Falls was designated; and, in 1976, ERDA's Hanford Reserve in central Washington state and parts of the Los Alamos Scientific Laboratory site in New Mexico were added to the list. In each case, care was taken to assure that the environmental research at the Park was compatible with the basic research, testing or production activities which were underway and which will continue.

All of these Parks are available to scientists throughout the country for a wide variety of environmental research. The non-ERDA research conducted at the NERPs may be funded by private companies, research foundations, universities or other government agencies.

FUTURE RESEARCH PARKS

ERDA is considering proposals to designate several more of its large sites as National Environmental Research Parks. Among them are the Oak Ridge (Tennessee) Reservation; the Nevada Test Site; the Brookhaven reserve on Long Island (New York); and, in cooperation with the U.S. Forest Service, a research area in the Loquillo National Forest of Puerto Rico which now is being used by the Puerto Rico Energy and Environment Center under an ERDA contract.

By establishing a network of environmental research areas, man may have the opportunity to test in advance the effects that new ideas or technologies may have on the environment.

(MORE)

THE PARKS

SAVANNAH RIVER NERP

Designated as NERP: 1972

Location: About 20 miles east of Augusta, Georgia on the South Carolina shore of the Savannah River.

Size: 190,000 acres (76,000 hectares)

History: The site was acquired in 1950 as the location for facilities to produce nuclear materials for national defense.

Environmental Features: The site includes a variety of land ecosystems which are representative of much of the Southeastern United States. Among them are swampland, pine and hardwood forests, a large man-made lake, old fields, an abandoned town site, marsh-covered Carolina Bays, and several streams and watersheds.

Wildlife: The site is home to at least two endangered species, the American alligator and the red cockaded woodpecker. In addition, the variety of wildlife includes quail, beavers, rabbits, possum, raccoon, bobcat, fox, deer and feral hogs.

ERDA Facilities On-Site: 1) The Savannah River Plant, operated for ERDA by the DuPont Company to produce nuclear materials. It includes long term storage of high level-wastes from the production process. 2) The Savannah River Ecological Laboratory, operated for ERDA by the University of Georgia.

IDAHO NERP

Designated: 1975

Size: 571,800 acres (229,000 hectares)

History: Since 1949, the site for testing various types of nuclear reactors. Originally called the National Reactor Testing Station; now, the Idaho National Engineering Laboratory.

(MORE)

Environmental Features: The site lies within the upper Snake River Plain. The average elevation is nearly 5000 feet (1515 meters) and it is typical of a cool temperature, desert scrub environment. It contains a variety of desert vegetation such as sagebrush, saltbrush and junipers, and several endangered plant species. High buttes of basalt and rhyolite dominate a landscape that also includes volcanic craters and cones and alluvial deposits which may have been ancient lake bottoms.

Wildlife: A rich variety of bird and animal life including endangered species such as the prairie falcon and pygmy rabbit. Hawks, eagles and doves, pocket gophers, weasels, kangaroo rats and pronghorn antelope also make their home on the reserve.

ERDA Facilities: The Idaho National Engineering Laboratory, operated for ERDA by Aerojet Nuclear, Inc. (The Nuclear Regulatory Commission's Loss of Fluid Test Facility also is located on the site.)

LOS ALAMOS NERP

Designated: 1976

Size: 27,000 acres (10,800 hectatres)

Location: North-central New Mexico in the county of Los Alamos.

History: Acquired in 1943 as the top secret site for the Manhattan Project's atomic bomb research laboratory. Transferred to the Atomic Energy Commission in 1947 and to the ERDA in 1975.

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Environmental Features: The Park is located on the Pajarito plateau, and consists of a series of mesas, or tablelands, separated by deep canyons running eastward from the volcanic Jemez Mountains to the Rio Grande Valley. It contains vegetation in three major continental life zones: 1) the upper Sonoran (juniper); 2) Transition (pinon, juniper, ponderosa pine); and 3) Canadian (fir, aspen). The land rises from 5600 feet (1700 meters) above sea level at the Rio Grande 10,560 feet (3200 meters) at the Jemez Mountains. There is an abundance of prehistoric Indian ruins, remains of 14th Century pueblos and settlements, and many 15th-to-17th Century sites which originally had three-story adobe buildings. Three specific areas within the NERP have been proposed as historic sites under the National Historic Preservation Act.

Wildlife: The wildlife include 4 species of fish, 9 of reptiles, 187 of birds and 37 species of mammals. Deer and elk migrate through the area seasonally.

ERDA Facilities: The Los Alamos Scientific Laboratory, operated for ERDA by the University of California.

HANFORD NERP

Designated: 1976

Size: 365,000 acres (146,000 hectares)

Location: Along the Columbia River in central Washington State, near the town of Richland.

History: Acquired in 1943 as the site for secret facilities to produce plutonium for the atomic bomb. Transferred to the Atomic Energy Commission in 1947 and to ERDA in 1975. The Arid Lands Ecology (ALE) Reserve on the Hanford site was a forerunner of National Environmental Research Parks. In 1966, 110 square miles (286 square kilometers) of the Hanford Reserve were set aside along the east face of Rattlesnake Mountain, to be used for protected environmental research. ALE is included in the new Hanford NERP.

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Environmental Features: Borders on the last free-flowing stretch of the Columbia River and is the only sizeable land area of desert steppe in the U.S. that is not heavily used for livestock grazing. The elevation ranges from 350 feet (106 meters) to 3600 feet (1090 meters). Topographic features include an extensive zone of advancing sand dunes, a series of vertical cliffs along the river, the Saddle Mountain range and several hills and buttes with interconnecting plains. Temperatures can exceed -20°F (-32°C) in the winter and more than 100°F (40°C) in the summer. Vegetation includes sagebrush, bluebunch wheatgrass, and salt desert shrubs such as spiny hopsage, winterfat and bitterbush. The Hanford Reserve also includes abandoned farms, towns and settlements and several archeological sites.

Wildlife: The reserve is home to blue herons, black crowned night herons, gulls, partridges, grouse, curlew and nesting Canada geese. Mule deer, coyote, bobcat, badger, muskrat and beaver and a variety of smaller mammals also live there. In the Columbia River adjacent to the Reserve are found Chinook salmon, steelhead trout, Rocky Mountain whitefish and sturgeon.

ERDA Facilities: The Hanford Engineering Development Laboratory, operated for ERDA by Westinghouse; the N-Reactor, operated by Douglas United Nuclear; high level waste storage farms, maintained by ARHCO; a fuel fabrication plant for the N-Reactor, operated by United Nuclear Industries; and the Pacific Northwest Laboratory, operated by Battelle Northwest.

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April 1977

FOUR-LEGGED C.B.'er---A mule deer at ERDA's Los Alamos National Environmental Research Park is marked with colored ear streamers and a numbered ear tag, and fitted for a radio transmitter (contained in a colored neck band). The deer is then released unharmed. The transmitter will permit accurate tracking of the animal, so that its movements, feeding habits and other life patterns can be studied. (LASL Photos, available from ERDA Photo Office)

LABS WITHOUT WALLS---ERDA's National Environmental Research Parks (NERP) are protected outdoor laboratories, where scientists can study the environmental impacts of man's activities with an eye toward minimizing harmful effects. Each Park represents a specific environmental region, with wide varieties of plants, wildlife and geological formations. Photo #1: About 100 pairs of Great Blue Herons make their home at the Hanford (Washington) NERP, where scientists study the behavior of this and other animals. #2: Samples of vegetation growing in the Los Alamos (New Mexico) NERP are taken to be tested for the presence of various chemical elements. #3: Los Alamos researchers create and measure seismic waves to analyze underlying geological strata. (Photos available from ERDA Photo Office, Washington, D.C. 20545)

Mr. BROWN. We next have what we will consider a panel of two witnesses—Dr. David Reichle from Oak Ridge and Dr. Burton Vaughan from the Pacific Northwest Laboratory.

Dr. Vaughan, I am hoping to visit the Hanford facility in a couple of weeks. Maybe you can give us some clues as to what we could see up there that would bear on the topic that we are discussing this morning.

Dr. VAUGHAN. We will be more than happy, Mr. Chairman. I think that your assistant should request specifically the nature of the things you would like to see so it gets routed right through our system.

Mr. BROWN. You gentlemen are welcome here this morning and we look forward to hearing about your own particular perspective on these matters. You may proceed in whatever fashion you desire.

STATEMENT OF DR. DAVID REICHLE, ENVIRONMENTAL SCIENCES DIVISION, OAK RIDGE NATIONAL LABORATORY

Dr. REICHLE. Thank, Mr. Chairman and members of the committee.

My name is David Reichle and I am the associate director of the Environmental Sciences Division of the Oak Ridge National Laboratory.

I feel that as a former member of the Research Advisory Committee to the National Science Foundation as well as being a current member of the Environmental Studies Board of the National Academy of Sciences, that the opinions that I am going to give this morning reflect those of a substantial portion of my professional peers.

I am a professional ecologist and have been involved in the research on the ecological effects of environmental pollution since 1964 and am responsible now for the scientific management of a multidisciplinary research staff of some 160 professional scientists.

When you address the question of NERP's, it is important to distinguish ERDA's National Environmental Research Park from related concepts by referencing the land use terminology employed by the Federal Committee on Ecological Reserves.

The Federal committee defines Research Natural Areas or RNA's in the sense of conservation reserves to protect unique and natural ecological features for scientific reference. The Experimental Ecological Reserves or EER's, which you will be addressing tomorrow, are essentially synonymous in concept with ERDA's NERP's and are protected landscape units where experimental, long term, and manipulative environmental research can be performed. This research is necessary to the science of ecology in order to develop the methods and data whereby the response of ecological systems to environmental stresses and other man-induced perturbations can be evaluated. I think it is important to note that the environmental sciences, and particularly ecology, are outdoor sciences, and that the ecological sciences do not presently have calibrated environmental laboratories equivalent to those of the physical and atmospheric sciences, and that such facilities are absolutely necesary to provide the baseline and time-trend responses of ecological systems to changing environmental conditions.

This developing network system of ERDA's NERP's is in a sense a forerunner of the Experimental Ecological Reserve network being studied by the Federal Committee on Ecological Reserves. A unique feature of the NERP's is the capability to perform experimental research on the landscape, with the data being available to local, State

and other Federal agencies that require such information to meet their responsibilities in land-use management and environmental decision-making. The environmental research parks already serve as a regional focus for environmental assessment activity.

It is important to note that the Experimental Ecological Reserve, I am using this term now synonymously with ERDA's NERP's, should not be misconstrued as a public relations device by which the Federal landholding agencies can retain lands which otherwise might be made available for private use. The EER, the Experimental Ecological Reserve, represents an important scientific resource. Not all of the Federal agencies, which have resource management, regulatory, environmental protection, or ecological health research responsibilities, not all of them have the land and water resources necessary to carry out the needed research and, equally as important, the baseline monitoring. The scientific community does not have sufficient access to adequate research sites to investigate ecological phenomena or, in particular, to pursue long term ecological effects studies. Suitable research sites representative of the important natural ecological systems across the Nation are rapidly disappearing.

I would only emphasize your earlier question to Dr. Liverman related to the acid precipitation problem. This situation illustrates the urgency of securing these sites and the historical record of data while they are still available for our baseline information.

The collaboration of the many Federal agencies, each responsible for various aspects of maintaining and protecting a quality environment, requires focal points necessary to protect their cooperative and comprehensive programs. These points can be illustrated more specifically.

Let us think first in the context of the ecological reserve as a unit at individual sites. Special reference areas can be set aside as long-term baseline monitoring points at which scientists can establish standards for the performance of normal, natural ecosystems.

Routine, baseline measurements of natural and managed systems can provide long-term tracking data and information on how these systems have responded to chronic, low-level pollution or other anthropogenic stresses.

Experimental, manipulative research, can be effected in contrast to the purely observational activities. This research can be used to elucidate the functional mechanisms of ecosystem response to pollution stresses. This leads toward predictive capabilities.

Information on environmental health trends and predictive knowledge of ecosystem responses to perturbation can be utilized in evaluating and solving environmental problems in the biotic region in which the experimental reserve exists.

Data and information management systems can be maintained to effect the expedient transfer of this kowledge to users.

Of course, the ancillary benefits of scientific management of these areas for protection of unique habitats, rare and endangered species, as well as the education of the public and the training of a future generation of scientists exists.

Second, if you look at the experimental reserve as a network, there are other advantages offered.

Within a network it is possible for the coordination of the reserves located in different environments across the Nation which can bring about early identification of critical environmental issues and initiate the quest for necessary information on an early time schedule.

In many instances, background information on water quality, atmospheric pollution, land-use impacts, and ecosystem effects can provide insight to potential environmental problems before they arise, as well as to suggest modes of action that will need to be taken to ameliorate or otherwise deal with these potential problems.

Also, the present status of the health of ecological systems for all regions of the country can be evaluated, as well as providing the basis for understanding past changes in the biotic environment and projecting future trends.

Last, within a network, it is possible for coordination and utilization of the land holdings of a variety of Federal agencies and other institutions, while assuring at the same time the availability of the scientific resources to the researchers and the transfer of information to decisionmakers.

ERDA's National Environmental Research Parks, as have been explained this morning, were established because the Agency had a mandate to fulfill certain environmental requirements. ERDA's environmental goals were delegated in large part to its contractor-operated national laboratories, each with a resident research staff and an experimental reserve which uniquely qualified them to address a number of critical environmental problems. As you know, this pattern persists today, and it is important only to underscore the fact that the ability of ERDA to exploit the potential of its NERP's has been due to the presence of its resident research staff at each of the sites.

Mr. BROWN. May I interrupt you there, Dr. Reichle?

Is Oak Ridge, for example, a site operated by Union Carbide, as I recall? Is it Carbide's responsibility to maintain and support the NERP'S research staff or is it ERDA's responsibility?

Dr. REICHLE. Carbide acts as the contractor to ERDA. The funding support for the research staff comes fundamentally from ERDA.

Mr. BROWN. I am trying to distinguish between the contractor employees and ERDA employees, and determine whether ERDA contracts with Union Carbide for the management of the entire staff or just the operation of certain facilities.

Dr. VAUGHAN. I might, Mr. Chairman, make a point in clarification here. It has not happened, I believe, at Oak Ridge, but for example the Pacific Northwest Laboratory, which I represent, is presently operated by the Battelle Memorial Institute, but it has been operated by three or four prior contractors. Operating contractors change. Many of the people stay, so I do not know how you interpret that. The corpus of people are essentially funded despite the upper management of the organization.

Dr. REICHLE. I think the distinguishing point is that the employees are employees of the contractor. The funding and programmatic goals are established between the research managers and the Federal agency in this case.

Mr. BROWN. We are talking about a fairly substantial number of people. You mentioned 160.

Dr. VAUGHAN. I might just add, I have no doubt in my mind that if our ERDA funding disappeared we would have some several hundred ecologists and related people out of work.

Mr. BROWN. That would be a tragedy—almost as bad as if we lost our Congressmen. [Laughter.]

Sorry for the interruption.

Dr. REICHLE. The advantages of being a NERP are substantial, both scientifically and administratively. I think it is important to identify some of these advantages as they relate to the potential EER's yet to be designated in other regions of the country possibly by other Federal agencies.

Some of these advantages are:

The assurance of continuing programmatic funding support.

The fact that you have protection of the outdoor environmental resource for long-term research.

By designation you have visibility to the scientific community for scientific cooperation and educational training.

That you have recognition by user groups and development of communication mechanisms as a result of this for dissemination of the information you are obtaining.

This usually requires the establishment of environmental information you are obtaining.

This usually requires the establishment of environmental information and data management systems to effect this.

Very importantly, you have a basis for emphasis on long-term research and biological trend monitoring.

NERP's help in the attraction of an outstanding research staff.

NERP's represent a depository of an historical data base on normal and perturbed systems in that region.

There are many examples that you have heard this morning of how ERDA NERP's serve to meet the mission objectives of that agency and, in fact, how they have interacted with other agencies to serve as a regional focus for environmental research.

I would like to give you a few examples from the Oak Ridge site to illustrate this point.

The Ecological Sciences Information Center has been established for the indexing, analysis, and dissemination of environmental information at Oak Ridge. Recently, we have completed a project for the Council on Enviornmental Quality in collaboration with the Office of Biological Services in the Department of the Interior, with ERDA, and with the National Marine Fisheries Service. This project consisted of a national inventory of biological monitoring programs by Federal, State, and private institutions. This is an example of the regional focus which an NERP can provide.

Another example is the Oak Ridge Walker Branch Watershed, which is one of the most precisely calibrated landscape research facilities in the country. It serves as one of the most detailed environmental reference systems for the biogeochemical transport and fate of pollutants at the landscape scale for the south central and southeastern United States. We are located within the Tennessee Valley region. We have substantial combustion of fossil fuels in this region and acid percipitation. And this watershed has contributed to our understand-

ing of some of these problems. It has already effected cooperative programs between ERDA, TVA, the Geological Survey, the Forest Service, NOAA, and the National Science Foundation, all interested in various aspects of these problems.

Another example is the Aquatic Research Laboratory located near the Tennessee Valley Authority's Melton Hill reservoir, which is a unique facility for applied ecological research on reservoirs in the Southeastern United States. This facility has supported research for ERDA, the Environmental Protection Agency, the Tennessee Valley Authority, and the Nuclear Regulatory Commission.

The Environmental Sciences Division at the Laboratory has recently served as the research manager of an over $11 million 7-year research program for the National Science Foundation. Our role in the International Biological Program involved the coordination of research and interaction with 49 universities, institutions, and governmental agencies in the deciduous forest region of the country. Some of this research was performed at Oak Ridge which, incidentally, is within sight of the surface mining activities in the coal fields of Appalachia.

This background information has become invaluable to us in applied problems in recent years in wildlife management, surface mining, regional land use planning, and an assorted series of water and atmospheric pollution problems in the multistate region.

In the near future, we anticipate that the Government reservation there will play an important role in R. & D. for ERDA's Division of Solor Energy on the use of biomass for fuels.

The ERDA Reservation is currently being utilized in a joint program in wildlife monitoring and management with theTennessee State Department of Wildlife Resources. This will include intensive, long-term monitoring of the game and nongame wildlife resources in the region.

These are but some examples, and I would like now to proceed to the essence of your directive to us on suggestions for legislative considerations.

Appropriate legislation, if enacted, should insure that the necessary Experimental Ecological Reserves are established and protected for scientific research. There are no comparable facilities available now. As I have mentioned earlier, these are vital elements in developing the data bases to assess the long-term integrity of our biological environment.

Legislation could use the pattern of the ERDA NERP's to insure that this research reserve network within ERDA can be augmented by other Federal agencies to form a comprehensive national network. The resource base offered by this network should be available to all groups with responsibilities and concerns to maintain the quality of our environment.

Specifically, legislation should include or at least recognize the following issues:

That long-term data are essential for predicting and evaluating changes in our environment. We cannot obtain a historical data base quickly when needed. Lead time planning and thought to the future is necessary.

As you have pointed out earlier in your questioning of Dr. Liverman, there is no formal mechanism even outside of ERDA's NERP's to insure that any Experimental Ecological Reserves would be established and protected.

I believe that protection and support of Experimental Ecological Reserves will be necessary to insure their continuation once they have been dedicated.

I think that it is very important in any legislation to understand that the success of any expanded network of ecological reserve should be responsive to the needs of the local management. The success of these EER's depends upon the need of the supporting Federal agencies to fulfill their mission objectives. The objectives of legislation should not be to subvert these needs, but simply to make these resources of these outdoor research facilities available to other user groups as well.

I think that there should be an identified funding basis to insure persistence of these units and the overall network that is not vulnerable to ephemeral funding.

I believe that serious consideration should be given to the concept of environmental laboratories as you have developed in H.R. 35 and H.R. 6379, which could establish nonprofit centers for environmental research that could be developed in conjunction with the regionally dispersed Experimental Ecological Reserves.

Lastly, I believe, that enabling legislation for a national network of EER's should insure the mechanisms for cooperation among the Federal agencies so that our national resources are aggregated and used optimally.

In summary, gentlemen, let me say simply that the scope and magnitude of some of the environmental issues which we are facing today are considerable. Many of us believe they can be addressed and most of them resolved. The members of this subcommittee are well familar with these problems and our time is not well spent in readdressing them this morning.

It is important to be aware of the fact that a diverse array of scientific institutions and Federal organizations not only identify these environmental problems and steps necessary to their resolution, but the concept of the Experimental Ecological Reserve has either been explicitly advocated by many or implied by most. I am submitting into the record pertinent reference documents which support these statements. (See appendix, starting with p. 303.)

Specifically, I would like to call to your attention the documented entitled, "Experimental Ecological Reserves—A Proposed National System," that was prepared by the Institute of Ecology for the National Science Foundation. In his report, many of the questions which you have asked are addressed. These include the evaluation of the scientific needs for such a network; the recommendation of optimal sites in the country; identification of the kinds of environmental problems which these EER's can uniquely address and recommendations for management alternatives for such a national network.

Mr. Chairman, I thank you for this opportunity.

Mr. BROWN. Thank you, Dr. Reichle.

I would like to proceed with Dr. Vaughan and then ask questions of both of you.

STATEMENT OF DR. BURTON C. VAUGHAN, ECOSYSTEMS DEPARTMENT, BATTELLE MEMORIAL INSTITUTE, PACIFIC NORTHWEST LABORATORIES

Dr. VAUGHAN. Mr. Chairman, we are grateful for the opportunity to present our views here. Some of what I have to say is similar to what Dr. Reichle has said, here, but I think our geographic setting is different.

As I indicated, Pacific Northwest Laboratory is an ERDA Laboratory administered by Battelle. I have been associated with ecological sciences since 1969 and am responsible presently for all work in this area for the Pacific Northwest Lab. We have about 120 scientists and technicians not counting cooperating members from other departments and perhaps the same number again of support people.

About 40 percent of this effort lies in work related to the Hanford NERP. The remaining 60 percent covers areas all over the country, and out of the country, including places like Cape Thompson and Lake Maracaibo, Venezuela.

A number of my staff members came to the Pacific Northwest Lab over 30 years ago when the plutonium production plant was first started. They are still with us and are still productive members.

Historically the concern was to document organisms in food chains and to determine radioactivity contamination levels, with the tight control present at Hanford it was soon obvious that this would be a well-contained operation without any major worries. In the process of doing this we developed an extensive data base for fish, plants, wildlife and other biota and even soil microbial populations.

Therefore concern very soon shifted to other consequences of large-scale landscape intervention, and, in particular to possible impacts on the Columbia River salmon fishery caused by the chemical and heat discharge from the nuclear reactor. I would like to call to your attention that in 1951, the first unclassified documents clearly indicated that heat and chemicals were likely to cause the principal environmental impact. These factors were spelled out in some detail.

As a consequence of this work, a variety of long-term ecological monitoring programs were established. These are programs we have a great deal of difficulty in now maintaining in the present day climate of narrow application focus, and I would like to give you just one small example, a rather straightforward one that deals with the Canada Goose.

Here, we have for 25 years measured nesting conditions and reproductive success of the geese. The islands of the Columbia River area still important breeding locations on their flyway and as the nine plutonium weapons production reactors started up, one-by-one, we tracked these very carefully. The concern was that something about the heat or the chemical discharge might in a subtle way impair the food base on which the geese depended during their nesting interval. No such thing ever happened, and in fact, we found that the populations were maintained very well through the years of operation of the nuclear reactors and even past the shutdown point.

Out of this two lessons were learned—there is usually a basis for establishing real cause for environmental impact and second, negative data can be extremely useful in connection with monitoring ac-

tivities, but only provided the experimental design is there—that is, they are statistically adequate and the proper specifics have been investigated. Also, a pretty good data base must have been amassed. Twice we had both of those things we were able to make some sense out of later declines in nesting sites which had to do with trespass by recreational visitors and boaters.

What is the nature of the data base which we did establish over these years? I think probably six points—(1) the plant communities were well identified. We had established an accurate history of prior disturbance. As several people have said earlier this morning, none of these sites is completely free of some degree of interference, but we had very good records, very good verification of what the nature of that prior disturbance was, and where we did in fact have pristine sites.

Savannah River has mapped extensively its ecology reserves. (2) We have done so also and have established numerous inviolate sites. As an accident of western development, some of these sites are considered to be pristine, that is, they are probably undisturbed since early geologic time.

(3) We had in addition commence a microclimatic mapping effort which is now sufficiently well along that the variability in prediction climate is quite accurate over the ALE reserve. (4) The soils have been mapped; (5) the animal populations, vertebrate and invertebrate, have been well classified. And (6) perhaps most important of all, there exists within the Pacific Northwest Lab a real multidiscipline team we can call on. We do not support the climatologists, we get them from another department. We do not do the hydrography, we get them from another department. And we have had the funding in place to make possible these long-term associations, similarly the soil scientists.

I would like to move now to the Arid Land Ecology (ALE) reserve which in some ways was the more formal predecessor of the NERP. This is an area of 120 square miles included within the 570 square mile Hanford NERP. That corresponds roughly to 400,000 acres for the NERP and something on the order of 80,000 acres for the ALE reserve. The ALE reserve is a natural watershed area from the top of Rattlesnake Mountain to the valley floor, from 3,500 feet to about 500 feet. It is surrounded by dryland wheat farming on one side and the Hanford Reservation on the other side. Hanford is referred to as a sage brush location. That is a little bit misleading. It is actually a short grass prairie location, very useful for dryland wheat or for grazing purposes. Sage brush is there. Bitter brush is there. Other plants are there, but there is also quite a bit of grass land. And there are locations within the reserve which were converted to cheatgrass fields in the early settlement years, these locations are apart from the inviolate areas.

In setting up the reserve we—10 or 11 years ago now—were obligated to do four things—to preserve the pristine locations indefinitely; to have sites that were specifically dedicated for manipulative research activities; to encourage outside university participation and this has been quite extensive as has Oak Ridge's; and, to very strictly control access by casual visitors.

In 1971 the Arid Land Ecology Reserve also became the Rattlesnake Hill's Research Natural Area under the 5-agency Federal Cooperation Agreement, and as you well know the key elements in that designation was the idea of preservation of undisturbed sites and the gene pools represented by organisms in those sites.

Later in 1977, Dr. Jerry Franklin of the U.S. Department of Agriculture examined suitable sites over the whole of the United States for the Biosphere Reserve program, and I would like to quote one statement he made—namely, "it was seldom possible to identify a single area that satisfied all criteria for a biosphere reserve, namely, a large strictly preserved tract for conservation of a full array of organisms with a substantial history of research and monitoring and the potential for major experimental treatments." And he added, "the only area that is clearly of this type is the Arid Land Ecology Reserve at Hanford."

To my best knowledge ERDA has not nominated the ALE Reserve for inclusion in the Biosphere Reserve program, but the stated objectives of the Biosphere Reserve program are exactly identical to the ALE Reserve as a segregated portion of the Hanford NERP.

Now, you might ask at this point how the Hanford NERP differs from the ALE Reserve. Well, fundamentally the main difference is this: We agree that in other portions of the Hanford NERP, large scale land intervention may take place. I think this is an important point. We have within the ALE Reserve most of the same plant communities and biotic representation that we have on the larger NERP. It is possible to use that baseline as a way of tracking those changes that happen, as we put energy production facilities on the larger NERP.

The ecologists make a distinction between modulation experiments and other kinds of experiments. Basically, a modulation experiment is something that is essentially reversible. It might be overhead spraying, controlled cattle grazing, certain types of stream modification. It is not the kind of activity that irreversibly changes the character of the land. We would propose to have only modulation experiments on the ALE Reserve, but other kinds of experimentation could be allowed on other portions of the NERP.

In my own mind, I do not think all things deserve to go on the Hanford NERP. We remain one of the few locations in the country that meet very stringent EPA Air and Water Quality Standards. Our sulfur concentrations are so low, they are of no consequence at this point. Other air quality parameters are fully met. The nuclear facilities have operated with no significant ecological impact. The portion of the Nuclear Fuels Reprocessing Plant which leads to slight land contamination is all strictly controlled and kept within further exclusion areas on the Hanford NERP. We have never seen what would be termed an impact on any biotic form caused by the operation of those facilities. There are some residual concerns about food chain transmission, but even these are at levels low enough to be no recognized hazard to human health at the present time.

By contrast with that type of a technology, I would be very worried about the prospect of a modern 3,000 megawatt coal fired plant. We do know that if the sulfur concentrations exceed something on the

order of 300 micrograms per cubic meter, we can expect to see some long-term changes on our type of ecologic system. There are other concerns which have been touched on in assessment studies cited in my reference list in the written material. They suggest that long-term metal problems would affect organic productivity. I do not know whether this is equally true in other parts of the country. In a high rainfall location, the problem may be less acute, than in a low precipitation area as represented by much of the arid west.

But I would submit to you that we need to give further thought as to the kind of technology that goes on some of these dedicated environmental research parks.

I would like now to move to questions of what kind of short-term measures are necessary to protect the NERP's. Following that, I would like to touch on some of the long-term matters.

We do not need to go into too much detail here, but in terms of short-term protection, I think, it is very important to have geographic identity. If you have a fenced area that is indistinguishable, it is almost impossible to police; also an area of 120 square miles is too large an area to foot patrol by any reasonable amount of money.

In our case, we have a natural watershed area on the southwest corner, and it is reasonably feasible to provide total surveillance by airplane. We think aerial surveillance is a much more practical technique than foot patrol, in many cases.

The second main point is that we need to have buffer zones. These are primarily for fire protection.

The third point is particular policies on fire control. Most firefighting is in the hands of fairly independent firefighting departments and it is seldom that their policies are reviewed for impact on the ecology. In our case, experience shows that bulldozer tracks from the firefighting equipment will scar the landscape and allow invasion by cheatgrass. This will persist for decades, whereas allowing the land to burn and regenerate on its own will preserve the natural vegetation. So we do not want bulldozers roaming over the reserve in a brush fire.

Also, if it becomes necessary to bring in spray planes, we do not want borate used, for reasons which I do not want to go into here.

The remaining point on short-term protection is a very strict use control policy. I have provided to the committee, in the written record, for an example of the type of policy we have used for many years for the ALE Reserve. We believe it is also applicable to the larger Hanford NERP. Basically, policy is to keep all casual visitors off except at certain designated visit times during the year, and people who enter, enter only bona fide scientific purposes.

So, recapping, we have the matters of geographic identity, buffer zones, fire control policy, use control policy, and how you patrol.

I might make one quick comment about the patrol. There is a delicate balance here between threat and actual force. In an area like ours where the trespassers will usually be local residents, our ever-present fear is that an irate resident may decide to deliberately set a brush fire if his perception of treatment at the hands of the patrol is too heavyhanded. Across the river from Hanford we see this frequently. It is a real problem.

Let me move quickly to what may be necessary by way of the long-term preservation of the Hanford NERP.

This is a much more difficult problem. I think that we need to have a clear sense of how the objectives of the NERP differs from EER's and Biosphere Reserves. Mainly the difference is that there will be designated portions of NERP which are appropriate to technology and other designated portions appropriate to let us say, Biosphere Reserve purposes. In our case, the latter is the ALE reserve. I think the long-term integrity of the NERP is closely tied up to what happens to the ALE Reserve.

Now, originally the ALE reserve came into existence as a buffer zone to prevent grazing and agriculture encroachment on the nuclear fuel reprocessing plant. If reprocessing moves to another location in the United States, or if the buried wastes at Hanford are dug up and put somewhere else, I think the ERDA would find it impossible to resist the pressures for agricultural development or for grazing. We have seen many examples of this. In fact, the NERP and the ALE reserve remain principally a matter of agency declaration, as Dr. Liverman has indicated to you. We have apprehended trespassers many times, people who cut our fences to let cattle graze, land development firms who have been on the reserve looking for water, and other matters.

Perhaps most serious is the pressure of other agencies. The interagency problem is a very difficult one to deal with, and at Hanford NERP, we have had to give up significant pieces of land over the years. General Services Administration, several years ago, for example, insisted on the sale of a strip of land on the southeast border of the ALE reserve which ERDA had been regularly leasing to a dryland wheat farmer as a buffer zone. The concept of a buffer zone was just not in GSA's scheme of things. When this land was released, it was turned over to the State Department of Fish and Game, and they, in turn, leased it to the county of Benton for use by recreational vehicles. The potential for uncontrollable brush fires was just unbelievable. Finally, after strong protest by our staff, Fish and Game decided to rescind its agreement. In my view, and this is just one small example; the land would have been much better managed if it had remained under ERDA control.

We have other pending matters: Bonneville Power Administration wants a 100-acre strip through the only bitter brush-sagebrush plant community we have within the reserve. There are other examples of this vegetation on the Hanford NERP, but they are not declared in protection status. I just do not know how we resist nibbling away of this kind.

As you can appreciate, a cost-benefit argument for detouring a power line reckoned against 100 acres out of 77,000 acres in our 15-year research cost just does not hold water. We are on very shaky ground to argue a matter like that, despite very strong cooperation from ERDA.

Some remaining matters which need to be looked into, and which I am simply not informed on, affect the legal status of unused easements and mineral rights on the land. This remains in the province of the local office of ERDA and they should be consulted on this matter.

I do not know whether we would be able to prohibit geologic exploration on the ALE site, for example.

I think a remaining point, if I could beg your indulgence for about 3 minutes more, needs to be said. In addition to clarifying the objectives, having a policy for clean technology on a NERP—perhaps clarifying legislatively the legal administrative status of a NERP—there has to be also a provision for long-term ecological monitoring. I have provided for the record an example of a number of different kinds of long-term projects we have. They represent a very small fraction of our total program, perhaps less than 10 percent. These are projects which have been going in some cases for 25 years and in other cases for 5 to 10 years. We are under increasing pressure to discontinue this kind of work because the prospect of somebody wading around in hip boots to sample fish for *columnaris* bacteria in the Columbia River, or somebody classifying grasshoppers and exotic beetles, or counting Canada goose eggs can be very frivolous-appearing to the uninformed taxpayer, to the biomedical scientist, or to the engineer concerned with technology. Yet I am sure many members of this subcommittee recognize that these very procedures may provide important data for judging ecological impact. But we have great difficulty finding those kinds of programs, and I am not awfully optimistic about their long-term continuity.

I would like to make a couple of further points here. Traditionally biological scientists, and this is certainly true of the biomedical community, depend on laboratory approaches—bioassay approaches—by comparison with field effort. Also, long-term ecological monitoring has to be distinguished from the type of short-term monitoring necessary to meet a licensing requirement for EPA or for the agency's technology. They basically have a different thrust.

Certain kinds of adverse impact can be forecasted on a 10- or 12-year basis provided the right kinds of experimental design is there, but members on our staff have published and pointed to the inadequacy of many present day monitoring designs.

I think that there is something analogous to the epidemiological approach used in medicine that needs to be applied to the environment; that is, looking at the wind rose data, finding appropriate plant communities since plants will usually be your most sensitive indicators, and tracking the nature of the changes.

You asked this question in connection with southern California photo-oxidant problems. I am sure that there was in fact a basis for predicting forest damage had the proper kind of monitoring been set up more than 20 to 50 years ago.

Another thing that requires looking at is the streamlining of ecological methods. I think ecologists themselves have done a poor job of setting sampling priorities. Also they are usually required to measure too many species, construct insensitive diversity indices, sometimes, or follow arbitrary sampling designs that are inadequate. In a terrestrial environment it might be far more important to get a handle on a reference habitat change or on primary productivity. In an aquatic environment it might be more important to track the life history and reproductive success of only one or two valuable species.

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Even after a good many years of ecological research, we simply cannot—and I think in principle we could know what the ultimate receiving capacity of a body of water is for mixed effluents. There is a basis for getting at these questions experimentally using ecosystems approaches, that is, holistic approaches, rather than approaching it from a bioassays point of view.

And similarly in the terrestrial environment I think there is a way of asking the question—will there be a significant impact on grazing, on agriculture productivity, or on forest productivity?

Without saying more, I thank you for the opportunity to make these points.

Mr. BROWN. Well, you have made them very well and very comprehensively, Dr. Vaughan, and you certainly have given us a clear picture of the scientific potential and value of these ecological reserves or similar sites.

I will just ask one question about a subject that is touched on in both of your statements, and that is your relationship with other agencies.

Each of you have indicated positive and negative aspects of interagency relationships. You have indicated that you have been under pressure from other jurisdictions, States, local, and other Federal agencies, possibly to use these lands for other purposes. I think both of you have also indicated that there has been considerable cooperation between various agencies.

I am concerned a little bit as to how we can enhance the cooperative relationships which exist and how we can inhibit the negative pressures coming from these various sources. It may be that the direction that we need to go will simultaneously solve both problems. It seems to me that what we need to do is to get more agencies concerned about supporting this kind of long-term scientific research. To the degree that we can, we should enhance the cooperation and reduce the pressures for nibbling away at the research sites and other things of that sort.

Now, to what extent can we do that? To what extent can we get the Forest Service, the Bureau of Land Management—and we will take this up with the Interior witnesses—State governments, and local governments to even participate in this kind of research and to recognize how it impacts on their own particular problems. Maybe there are cooperative programs already in existence that I do not know about; you might comment on that.

I would think that, for example, the Forest Service with its various National Forests, the Park Service with its parks, and the custodians of the various Wilderness Areas might have programs similar to those that you have discussed already. Perhaps we need to amplify on those programs.

Dr. VAUGHAN. Well, I would like to make one comment relative to that. I think it would be excellent to try in any way possible legislatively to broaden the agency understanding and the need for ecological research however that can be done. But I think there is also a fundamental philosophical difference in point of view. Everywhere

you turn in an agency charged with development responsibilities you run into the engineer armed with cost benefit techniques. Unfortunately it is very difficult to set a meaningful price, let us say, on what is lost if you irreversibly change a preservation area. So, the point I made with Bonneville Power Administration is typical of many such discussions we have had. How you prevent nibbling away a reserve because in some way somebody says, how much manpower have you on this reserve? And what was the total invested research? And what fraction of the total are we impacting? You have a nibbling process that by degrees takes it away.

We cannot put into the equation at this point a meaningful cost on sites necessary to examine the functioning, the holistic functioning, of ecologic systems. We just do not know how to do that. Because of that you get caught on this philosophical dilemma. So in my own view I feel a legislative mandate is probably necessary, but I recognize that it has to go beyond that. We have to convince people who have a hard time understanding.

Dr. REICHLE. Let me proceed from the general to the specific elements of your statement. There are other Federal agencies which, in concept and in operation, have similar ventures to ERDA's NERPs; I think you will be hearing about some of those tomorrow. A number of these installations have interacted and collaborated. To date the collaboration occurs on a scientific level because of the scientific interests and need for data and information.

Many of the agencies and organizations have difficulty in securing or identifying a firm line-item funding base to support their EER's. The expenses—as the EER report summarizes—are not as great as you might thing, because the costs of EER's are in large part in purchasing the land. Much of the needed land is already there. It is the effective utilization for the long-term studies which needs to be supported.

Cooperation needs to be effected in recognition of the environmental problems which need to be addressed, and this is complicated by the dispersion of environmental insterests and responsibilities among a number of agencies. Sometimes the seemingly unwillingness to cooperate is more a problem of identifying who really has the responsibilities. One advantage that these central focus of EER's could provide, rather than each agency pursuing their own interests separately, is a place where various agencies and institutions who have an environmental mandate can come together and collaborate. At Oak Ridge we have been very successful in cooperation with a number of agencies.

I did not elaborate on the problems of losing land. In part that is due to the fact that we do not have enough land to lose. While some of the problems of the other NERP's lie in keeping what land they have, Oak Ridge, if designated as a NERP will be the smallest of ERDA's NERP's—perhaps one-tenth the size of any other. Yet within our reservation boundary, we continue to try to expand our activities to meet ERDA's mandate for the non-nuclear energy technologies. Within our boundaries we can look at the coal fields of Applachia, but

we do not have any controlled access to these lands at the present time for long term research. There has been a lot of focus on western coal extraction which is an important issue. The east also has a great deal of surface mining activity. In fact, that is one of our particular concerns, and I would like to raise in your consciousness the need to acquire additional land for long term ecological research on surface mining in Applachia under the aegis of the NERP/EER concept. We should appreciate your assistance in this regard.

Mr. BROWN. Our hope is that these hearings will help raise the consciousness of a number of people with regard to the significance of what you are doing. Whether we like it or not, we are conducting a number of unplanned inadvertent experiments today throughout our society which we would not conduct if we had a background of data that would indicate the effects of some of these experiments. I am referring generally to the health and environmental impacts of small quantities of foreign material, pollutants, poisons, what have you, in the air, water and land. Since we have allowed this to take place, we are going to see a lot of our population have their lives shortened because we have not intensively studied the impact of many things on our environment and our ecology, human and otherwise.

As we learn more about the results of some of these inadvertent experiments, for example, the so-called carcinogens that are shown to be in the Mississippi River, we are going to be more and more interested in finding out the impact of perturbing factors on all sorts of systems and how they operate.

Gentlemen, we have a time problem. We need to hear several more witnesses this morning and because of that, I am going to forego any further questioning at this point.

We do appreciate your testimony. It was extensive and detailed and and will be extremely helpful to us as we pursue this subject further. Thank you very much.

[The prepared statements of Drs. Reichle and Vaughan follow:]

TESTIMONY PRESENTED TO

SUBCOMMITTEE ON ENVIRONMENT AND THE ATMOSPHERE

U. S. HOUSE OF REPRESENTATIVES

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Hearings on Environmental Research Reserve Networks

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*Operated by Union Carbide Corporation for the Energy Research and Development Administration.

I. INTRODUCTION

A. Personal Qualifications

My name is David E. Reichle. I am Associate Director of the Environmental Sciences Division of the Oak Ridge National Laboratory. My staff and I have been instrumental in developing the research plans for initiation of a National Environmental Research Park on the ERDA Reservation at Oak Ridge, Tennessee. Also, I have assisted the ERDA Division of Biomedical and Environmental Research during the past four years in the development of their National Environmental Research Park program. Prof. George H. Lauff of Michigan State University and I have served as co-managers of a comprehensive analysis for the National Science Foundation by The Institute of Ecology on "Experimental Ecological Reserves -- A Proposed National System" on which you will hear testimony tomorrow. As a former member of the Research Advisory Committee to the National Science Foundation, current member of the Environmental Studies Board of the National Academy of Sciences, and council member of the Ecological Society of America, I can assure you that the following scientific judgments and opinions reflect those of a substantial portion of my professional peers. I am a professional ecologist who has been personally involved in research on the ecological effects of environmental pollution since 1964 and am currently responsible for the research management of a multidisciplinary group of over 160 scientists working in this field.

B. Definition of National Environmental Research Parks

A National Environmental Research Park (NERP) is an outdoor experimental laboratory established by the Energy Research and Development Administration to meet the nation's environmental goals, as established by the National Environmental Policy Act (NEPA) of 1969 . It is important to distinguish a NERP from related concepts through reference to land-use terminology employed by the Federal Committee on Ecological

Research. The Federal Committee defines Research Natural Areas (RNAs) in the sense of conservation reserves to protect unique and natural ecological features for scientific reference; Experimental Ecological Reserves (EERs) are synonymous in concept with the NERPs and are protected landscape units where experimental, long-term, manipulative environmental research can be performed. This research is necessary to the science of ecology in order to develop the methods and data whereby the response of ecological systems (ecosystems) to environmental stresses and man-induced perturbations can be evaluated. It is important to note that the environmental sciences, particularly ecology, are outdoor sciences; that the ecological sciences do not presently have calibrated environmental laboratories equivalent to those of the physical and atmospheric sciences; and that such facilities are absolutely necessary to provide the baseline and time-trend responses of ecological systems to changing environmental conditions.

The Energy Research and Development Administration has established a national network of Environmental Research Parks which currently consists of four NERPs - Hanford (Arid Lands Reserve), Washington; Idaho Falls, Idaho; Los Alamos, New Mexico; and Savannah River, South Carolina. The Oak Ridge, Tennessee NERP implementation plan is presently under agency review. This developing network system was a forerunner of the Experimental Ecological Reserve (EER) Network being studied by the Federal Committee on Ecological Research. The ERDA NERP network envisages both broad geographic distribution and representation of diverse ecosystem types, and encompasses a more than 20-year record of baseline ecological conditions. A unique feature is the on-going capability to perform experimental research on the landscape, with the data available to local, state, and Federal agencies that require such information to meet their responsibilities in land-use management and environmental decision-making. Additionally, these parks are also conceived as providing a regional focus for environmental assessment activities.

II. THE ROLES OF EXPERIMENTAL ECOLOGICAL RESERVES

Experimental Ecological Reserves should not be misconstrued as a public relations device by which Federal land-holding agencies can retain lands which would otherwise be made available for private use. The EER represents an important scientific resource. Not all of the Federal agencies which have resource management, regulatory, environmental protection, or ecological health research responsibilities have the land and water resources necessary to carry out the needed research and/or baseline monitoring. The scientific community does not have sufficient access to adequate research sites to investigate ecological phenomena or pursue long-term ecological effects studies. Suitable research sites representative of important natural ecological systems across the nation are rapidly disappearing. Collaboration of the many Federal agencies, each responsible for various aspects of maintaining and protecting a quality environment, requires focal points necessary for the investitures of the agencies so that expenditures can be optimized and comprehensive programs coordinated. These concepts can be elaborated more specifically.

A. The Experimental Ecological Research Unit

At each EER site:

- Special, undisturbed (control) areas can be set aside as long-term baseline monitoring points at which scientists can establish performance standards for normal ecosystems.
- Routine, baseline measurements of natural and managed (including agronomic) ecosystems can provide long-term "tracking" data and information on how these systems have responded to chronic, low-level pollution or other anthropogenic stresses.

- Experimental, manipulative research, in contrast to purely observational activities, can be performed on landscape units of the environment, which integrate atmosphere, geology, and hydrology with environmental biology, to elucidate the functional mechanisms of ecosystem response to pollution stresses.
- Information on environmental health trends and predictive knowledge of ecosystem responses to perturbation can be utilized in evaluating and solving environmental problems in the biotic region which the EER represents.
- Data and information management systems can be maintained to effect expedient transfer of knowledge to users.
- Ancillary benefits result in the scientific management of unique habitats and protection of rare and endangered species occurring on the EER, regardless of ownership, as well as education of the public and training of scientific specialists.

B. The Experimental Ecological Reserve Network

With an EER network:

- Coordination of EERs located in environments across the nation can effect early identification of critical environmental issues and initiate the quest for necessary information on an early time schedule.
- In many instances, background data on water quality, atmospheric pollution, land-use impacts, and ecosystem effects will provide insight on potential environmental problems before they materialize, as well as suggest modes of action that will need to be taken to ameliorate or otherwise deal with the potential problem.
- The present status of the health of ecological systems for all regions of the country can be evaluated, as well as providing the basis for understanding past changes in the biotic environment and projecting future trends.

- Coordination and utilization of the land holdings of a variety of Federal agencies and other institutions can be effected, while assuring the availability of the scientific resources to researchers and the transfer of information to decision-makers.

III. THE NATIONAL ENVIRONMENTAL RESEARCH PARK

ERDA's National Environmental Research Parks were established because the agency had a mandate to fulfill certain environmental requirements and this was the most effective means to accomplish the goals derived from this mandate. ERDA's requirements were to develop the needed data base and to assess the potential environmental impacts of developing energy technologies -- all aspects of nuclear and non-nuclear fuel cycles, from mining through energy conversion to waste management. ERDA's environmental goals were delegated to its contractor-operated National Laboratories, each with a resident research staff and an experimental research reserve which uniquely qualified them to address critical environmental problems in their regions. This pattern continues today, and the assistance that these National Laboratories also have provided to other environmental agencies has been substantial. It is important to note that the ability of ERDA to exploit the potential of its NERPs has been due to the presence of a resident environmental research staff at the NERP site.

A. Institutional Advantages of Being a NERP

The advantages of being a NERP are substantial, both scientifically and administratively, although to use the perspective of the Oak Ridge site to illustrate these advantages understates the case. This is because the presence of the 36,000-acre ERDA Reservation in Oak Ridge has already enabled us through the years to develop as a NERP prototype. It is important to identify the basic advantages of being a NERP as they relate to potential EERs yet to be designated in other regions of the country by other Federal agencies. These advantages are:

- Assurance of programmatic funding support,
- Protection of the outdoor environmental resource for long-term research (as opposed to conservation),
- Visibility to the scientific community for scientific cooperation and educational training and to the public for better understanding of environmentally related problems,
- Recognition by user groups and development of communication mechanisms for information dissemination,
- Establishment of an environmental information and data management system.
- Emphasis on long-term research and biological trend monitoring,
- Attraction of an outstanding, multidisciplinary research and assessment staff, and
- Development of an historic data base on normal and perturbed ecosystems.

B. Examples of NERP Activities at Oak Ridge

There are many examples of how the National Environmental Research Parks serve to meet the mission objectives of ERDA and interact with other agencies to serve as a regional focus for environmental research. The following examples illustrate the potential roles that other similar environmental reserves could also serve in meeting the nation's environmental research needs. As selected examples, at Oak Ridge:

- The Ecological Sciences Information Center has been established for the indexing, analysis, and dissemination of environmental information. Recently, a project was completed for the Council on Environmental Quality in collaboration with the Office of Biological Services (USDI), ERDA, and the National Marine Fisheries Service (USDC). This project consisted of a national inventory of biological monitoring programs by Federal, state, and private institutions. This is an example of the regional outreach which the NERP focus can provide.

- The Oak Ridge Walker Branch Watershed is one of the most precisely calibrated landscape research facilities in the country. It serves as the most detailed environmental reference system for the biogeochemical transport and fate of pollutants at the landscape scale (coupled atmosphere-geology-hydrology-biology) for the deciduous forest biome of central and southeastern United States. It has already effected cooperative programs between the Energy Research and Development Administration, the Tennessee Valley Authority, the U.S. Geological Survey, the U.S. Forest Service, the National Oceanographic and Atmospheric Administration, and the National Science Foundation.

- The Aquatic Research Laboratory at Oak Ridge (with computer-programmed temperature regimes, experimental holding tanks up to 0.25 acres, living streams, and the only large-scale experimental entrainment research facility in the southeast) is located near the TVA Melton Hill Reservoir, and represents a unique facility for applied, ecological research problems on reservoirs of the southeastern United States. This facility has supported research for the Energy Research and Development Administration, the Environmental Protection Agency, the Tennessee Valley Authority, and the Nuclear Regulatory Commission.

- The Environmental Sciences Division at Oak Ridge National Laboratory served as the research manager of the $11.4 million, 7-year, eastern forest component of the National Science Foundation's International Biological Program. This role involved coordination of research by and interaction with 49 universities, institutions, and governmental agencies. Some of this research was performed at the Oak Ridge site, and this background information has become invaluable to applied problems of wildlife management in southeastern forests, surface mining in the mountainous regions of Appalachia, regional land-use planning, and water and atmospheric pollution problems in the multi-state region.

- In the near future it is anticipated that the Oak Ridge Reservation will play an important role in the research and development program of the ERDA Division of Solar Energy on production of forest biomass for fuels. This program could utilize the unique resources of the Oak Ridge experimental reserve -- land for experimental R & D, extensive data on forests of the region, and extensive collaboration with contributing research institutions in the region.
- The ERDA Oak Ridge Reservation is currently being utilized in a joint program in wildlife monitoring and management with the Tennessee State Department of Wildlife Resources. This program will include intensive, long-term monitoring of the game and nongame wildlife resources in the region.

IV. LEGISLATIVE REQUIREMENTS

Appropriate legislation should be enacted to ensure that the necessary Experimental Ecological Reserves (EERs) are established and protected for scientific research. There are no comparable facilities available now. These facilities will be vital elements in developing the necessary data base to assess the long-term integrity of our biological environment in the face of accelerated changes in the environment induced by human activities. Legislation should ensure that the prototype environmental research reserves established by ERDA are augmented by other Federal agencies to form a comprehensive national network. The resource base afforded by this network should be available to all groups with responsibilities and concerns for maintaining the quality of our environment. Appropriate legislation should include or recognize the following issues:

- Long-term data are essential for predicting and evaluating changes in our environment. These data cannot be obtained quickly -- lead time planning for the future is necessary and once the opportunity is lost, it often cannot be regained.

- No formal mechanism outside of the ERDA NERPs currently exists to ensure that Experimental Ecological Reserves will be established and protected.
- Protection and support of Experimental Ecological Reserves will be necessary to ensure their continuation once they have been dedicated.
- Legislation establishing an EER network should be responsive to the needs of the local site management. The success of the EER depends upon the need of the supporting Federal agencies to fulfill their mission objectives . The objective must not be to subvert these needs, but to make these resources available to other user groups.
- There must be an identified funding basis to ensure persistence of the individual EER sites and the overall network that cannot be vulnerable to ephemeral financial plans of the supporting Federal agencies or the Office of Management and Budget.
- Serious reconsideration should be given to the concept of National Environmental Laboratories (Serial No. 92-3, 1971), as developed in HR35 (Environmental Research Centers Act of 1975) and HR 6379 (Environmental Research Act of 1977), to establish non-profit center(s) for environmental research that could be developed in conjunction with the regionally dispersed EERs to ensure their effective and optimal utilization.
- Enabling legislation for a national network of EERs must ensure the mechanisms for cooperation among Federal agencies so that our national resources (institutional, scientific, and fiscal) are aggregated and used optimally.

V. CONCLUDING REMARKS

The scope and magnitude of the environmental issues which our nation faces today are considerable, but all can be addressed and many resolved. The members of the Subcommittee on Environment and the Atmosphere are intimately familiar with these issues and our time today

is not well spent readdressing these. A diverse array of scientific institutions and Federal organizations have identified these environmental problems and steps necessary to effect their resolution. The concept of the Experimental Ecological Reserve has been explicitly advocated by many and implied by others. I am submitting pertinent reference documents into the record of these hearings as supporting evidence. Evaluation of the scientific needs for a network of EERs, recommendation of optimal EER sites, identification of the kinds of environmental problems which can be addressed with EERs, and recommendations for management alternatives for a national network are set forth in a document prepared by The Institute of Ecology for the National Science Foundation entitled Experimental Ecological Reserves - A Proposed National System.

VI. ADDITIONAL MATERIALS FOR THE HEARING RECORD

The Role of Ecology in the Federal Government. 1974. Response of Committee on Ecological Research. Council on Environmental Quality and Federal Council for Science and Technology. U.S. GPO Stock No. 038-000-00202.

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The Nature Conservancy News. Spring 1977. Prairie Preserves as Research Facilities, pp. 26-27, by Paul G. Risser.

Proceedings of the National Environmental Research Park Symposium. 1974. Idaho Falls, Idaho.

Experimental Ecological Reserves - A Proposed National System. 1977. The Institute of Ecology. U.S. GPO Stock No. 038-000-00321-6.

Environmental Sciences at Oak Ridge National Laboratory. 1976. UCC-ND-1976. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Report on GAO Land Use Planning and Control Symposium. 1976. Resources and Economic Development Division, General Accounting Office.

Preserving Sites for Long-Term Environmental Research. 1976. Mosaic 7:29-33. National Science Foundation.

The National Biological Monitoring Inventory. 1977. Biological Indicators of Environmental Quality, J. J. Reisa (ed). Council on Environmental Quality, Washington, D.C. (in press).

TESTIMONY OF BURTON E. VAUGHAN, JULY 28, 1977, BEFORE THE HOUSE SUBCOMMITTEE ON ENVIRONMENT AND ATMOSPHERE, COMMITTEE ON SCIENCE AND TECHNOLOGY, U.S. HOUSE OF REPRESENTATIVES, THE HONORABLE GEORGE E. BROWN PRESIDING.

Mr. Chairman, Members of the Subcommittee:

I have been asked to give my views on several questions relating to operation of the National Environmental Research Park (NERP) at Hanford, Washington (1). Although Hanford's NERP was dedicated in March 1977, major elements of the NERP Program have been in place for over a decade. The program has even earlier antecedents; therefore, I would like to outline briefly our experience and events leading to dedication of Hanford's NERP.

BACKGROUND ON THE PACIFIC NORTHWEST LABORATORY

Hanford's NERP is administered, of course, by the ERDA, with its principal research programs conducted by the Pacific Northwest Laboratory operated by Battelle Memorial Institute. I am an employee of Battelle, with management responsibility for all programs in the ecological sciences (2). Beyond the programs I represent, PNL is a multiprogram national laboratory, employing about 2,000 people. Ecological sciences programs are funded principally by ERDA's Division of Biomedical and Environmental Research, although we also do work for other ERDA components and some other agencies. Programs in the ecological sciences support about 120 scientists and technicians, with 40% of the effort directly or indirectly related to the Hanford site. Several of our staff came to Hanford over 30 years ago when AEC's plutonium production plant was first established. Despite an initially nuclear orientation, an understanding of arid lands ecology grew out of these long associations with the Hanford region.

Primary concern, historically, was to document organisms in food chains that might lead to man and to determine radioactivity contamination levels. In developing the data base for fish, plants, wildlife and other biota, concern soon shifted to other consequences of large-scale landscape interference, for example possible impacts on the Columbia River salmon fishery caused by discharge of chemicals and heat from the nuclear reactors. I believe it important to note that in 1951, our fishery ecologists recognized other reactor residuals as having far greater potential for causing environmental damage than did radioactivity itself (3). Consequently, several long-term ecological monitoring programs were established that helped substantially to develop at Hanford a nuclear industry which was comparatively free of environmental problems. Let me give you one small but straightforward example.

For 25 years, we measured nesting conditions and reproductive success of the Canada goose on islands in the Columbia River at Hanford (Figure 1). This is still an important breeding location on the flyway for spring and fall migrations of the geese. As nine plutonium weapons reactors started up, reaching peak operation from 1944 to 1956, goose breeding was maintained--the concern was that subtle impairment of the food base on which the nesting geese depended might have occurred indirectly as a consequence either of reactor operations or nuclear fuel reprocessing activities. No such thing occurred, although several years after the last reactors were shut down several declines in Canada goose population were noted. These declines, occurring as they did after weapons reactor operation ceased, were traced to two extraneous factors;

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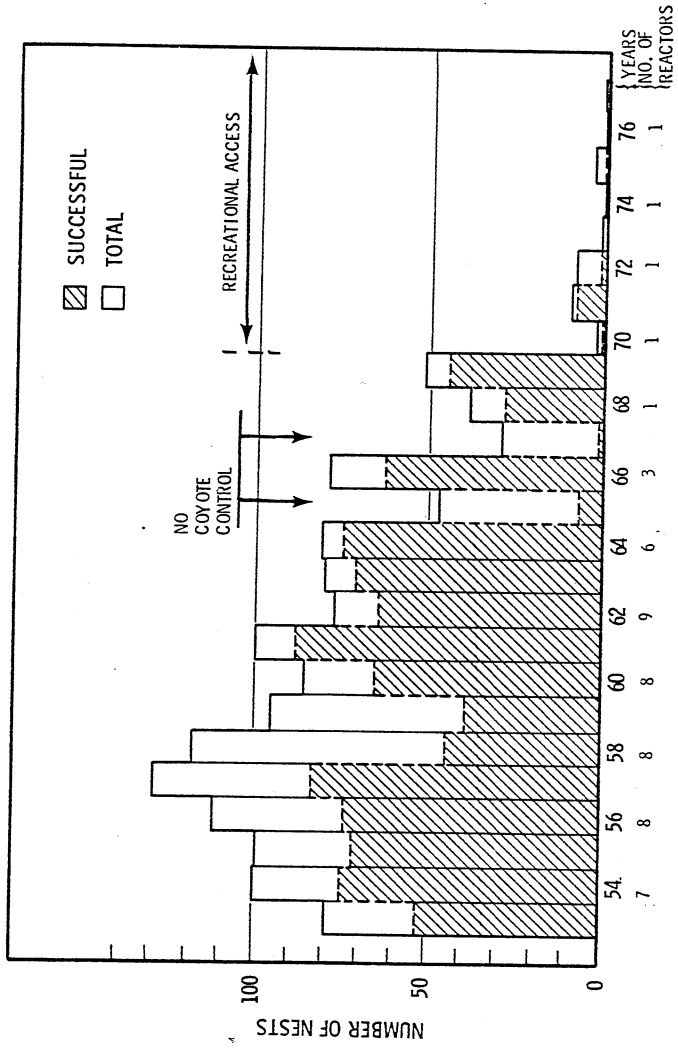

FIGURE 1. Number of Canada Goose Nests Established On Island 6 (Locke Island) Hanford Reservation and The Number of Successful Nests, 1953-1977.

namely, the opening of formerly restricted river locations to recreational boating and the suppression of long-practiced measures to control coyote populations (Figure 1). Out of this long-term monitoring effort two lessons were learned: 1) there is usually a basis for establishing cause of environmental impact, and 2) negative data as to another, presumptive cause of impact can be extremely useful. These points will be true only if the ecological monitoring project was properly designed at the outset and a good background of information had been amassed about ecological relationships of other organisms. For the example given, my predecessors' foresight in looking beyond narrow, immediate concerns, and the long-term continuity of effort set the stage for properly attributing consequences of other, unrelated developments.

ARID LANDS ECOLOGY RESERVE - RELATION TO OTHER NATIONAL SITES

With the above example in mind, I would like to turn, now, to consideration of the Arid Lands Ecology (ALE) Reserve. This is an area of 120 square miles included within the 570 square miles of the Hanford NERP (4). The ALE Reserve comprises the watershed area along the western border of the Hanford site from the top of Rattlesnake Hills (3,500 ft) to the valley floor (500 ft). It is an island of natural vegetation surrounded by expanses of cultivated field under dryland or irrigated management regimes, on the southwest side, and the Hanford nuclear facilities on the northeast side (Figure 2). In several ways the ALE Reserve is the forerunner of our present NERP. It was set aside 10 years ago by administrative decisions of the local office of AEC, now ERDA, in Richland, Washington. An important consideration at the time was to provide buffer area for the nuclear fuel reprocessing plant such that grazing and agricultural encroachment on the Hanford site would be minimized. This consideration coincided fortuitously with desires of our research sponsors to more systematically categorize this desert shrub-steppe ecosystem, common to a substantial part of the arid West where the AEC had many of its facilities. With support from the local office, steps were taken to map, fence, and patrol the ALE Reserve. Key elements of understanding were:

- Pristine locations within the Reserve would be preserved indefinitely
- Other sites within the Reserve would be dedicated for manipulative research activities
- Outside university participation would be encouraged in the research program
- Casual access would be strictly controlled.

(For any part of the landscape to be pristine, in 1968, was something of a geological and climatic accident--the weather generally was too hostile for early Washington settlers to be attracted to this site.)

In 1971, the Arid Land Ecology Reserve also became the Rattlesnake Hills Research Natural Area, as part of a five-agency Federal cooperative agreement. A key element in that designation was the idea of preserving undisturbed sites and the gene pools represented by all types of organisms found naturally at

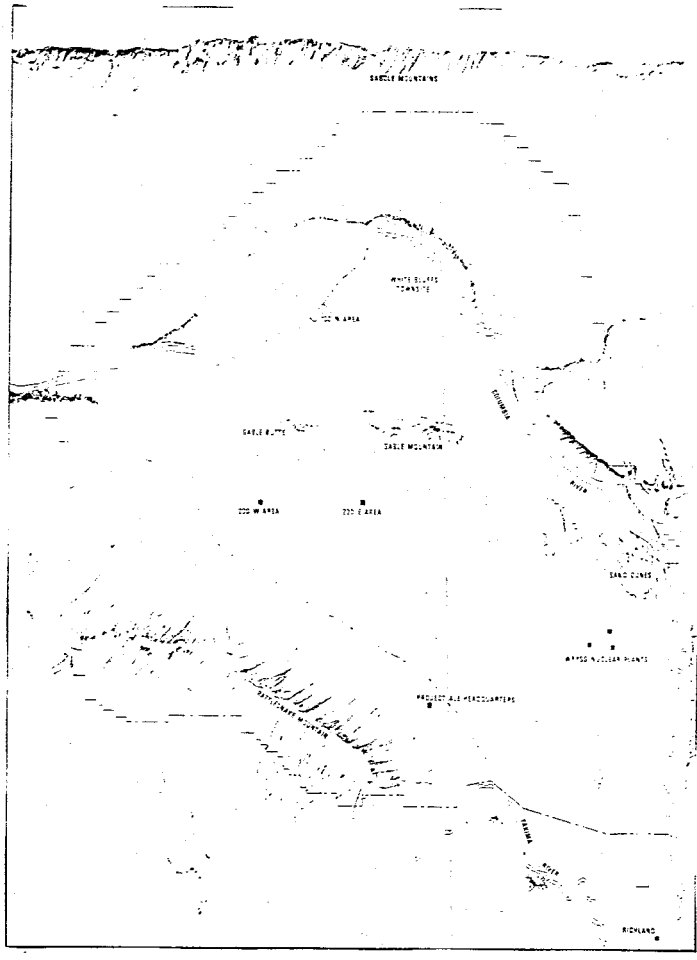

FIGURE 2. The Hanford National Environmental Research Park

those sites, especially rare and endangered or threatened types (5). These goals were consistent with the prior intent in establishing large segments of the ALE Reserve. In 1977, Dr. Jerry Franklin, of the U.S. Department of Agriculture examined suitable sites over the whole of the U.S. for the Biosphere Reserve Program (Figure 3) (6). He stated that..."It was seldom possible to identify a single area that satisfied all criteria--a large, strictly preserved tract for conservation of a full array of organisms with a substantial history of research and monitoring and potential for major experimental treatments. (The only area that is clearly of this type is the Arid Lands Ecology Reserve at Hanford, Washington)..." To my best knowledge, ERDA has not yet nominated the ALE Reserve for inclusion in the Biosphere Reserve Program. However, the stated objectives of the Biosphere Reserve Program are fully congruent with those in effect on the ALE Reserve, *as a segregated portion of the Hanford NERP*. One should note that policies for the ALE Reserve are more restrictive than those for other parts of the Hanford NERP.

HOW DO REQUIREMENTS OF A BIOSPHERE RESERVE DIFFER FROM THOSE OF THE HANFORD NERP?

The ALE Reserve at Hanford fulfills the three main objectives of the Biosphere Reserve Program: 1) conservation of unique landscape elements, 2) a place where long-term ecological monitoring and research are in progress, and 3) education. Excluded on the ALE Reserve are those large-scale land interventions which would permanently alter its character. Manipulative research is conducted at the ALE site--what the ecologists term "modulation" experiments. These experiments may involve overhead spraying, controlled cattle grazing, stream modification and other procedures whose effects are generally reversible. The extent and location of such experiments are further controlled, with buffer areas also provided. In this way, modulation experiments do not impinge on the areas designated for long-term preservation as required for our status as a Federal Research Natural Area, or as would be required for the Biosphere Reserve Program.

In contrast to the ALE Reserve, the larger Hanford site (NERP) includes areas where there exist new facilities for commercial nuclear electric power generation, the Federal nuclear production and reprocessing plants, and other high technology developments. Huge stretches of the 570 square mile NERP site also remain comparatively undisturbed. To date, possible radiological emissions from the nuclear facilities have been very tightly controlled so that measurable environmental impact of radiation has neither been expected nor has ever been detected. Also, operation of these facilities has been remarkably free from other adverse ecological impact on this region; e.g., thermal effluent discharges from the nuclear reactors. Nevertheless, it would be inappropriate for the *entire* Hanford NERP to be dedicated as a Biosphere Reserve. Only the ALE Reserve should be so dedicated. In my judgment, large sections of the present Hanford NERP can be used for clean technologies, like the nuclear facilites, whose operation is unlikely to significantly impact natural ecosystems. On the other hand, some different technologies could be inappropriate and might lead to long-term deterioration of the ALE Reserve. Studies in our laboratory and elsewhere indicate, for example, that long-term operation

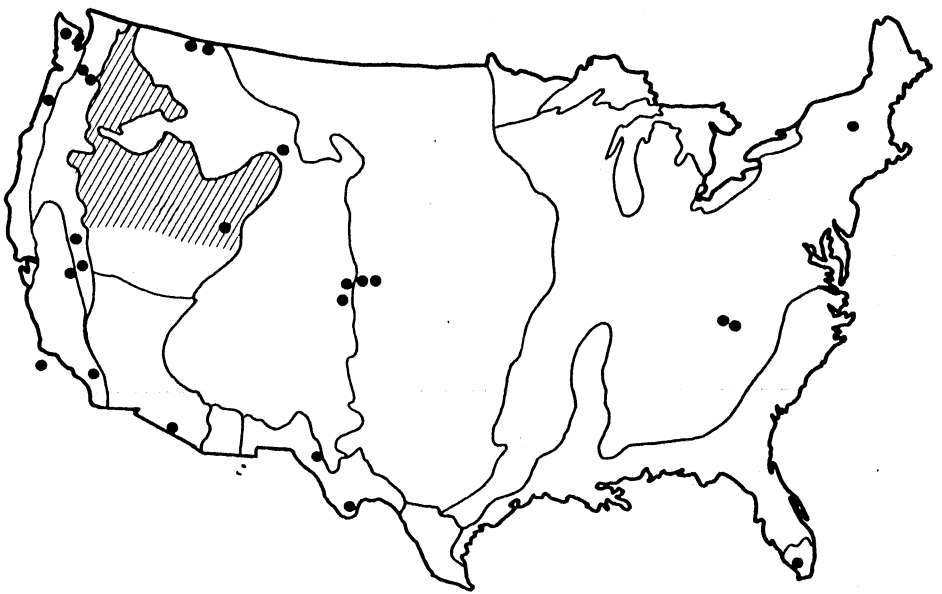

FIGURE 3. Location of Presently Established (dots) Biosphere Reserves. Reproduced with Permission of Science 195:263; 1977.

of large-scale coal-fired steam electric plants might cause impairment in organic productivity (7). To date, I am unaware of any definite policies as to type of technology to be allowed on the Hanford NERP. We shall probably have to pay close attention to this matter in future developments.

Many ecologists believe that one of the most useful indicators of biological potential of land is the mosaic of natural plant communities that occur with changes in elevation, topography, and soil substrates. Eight major plant communities have been characterized on the Hanford NERP. All are represented within the ALE Reserve except streamside communities, which lie along the Columbia River shore (4). The streamside communities provide principal habitat for many of the large animals of the Hanford NERP, and they are not currently in a protected status like that of the ALE Reserve. As several such sites lie outside areas committed to technology development, they should, in my view, be accorded Reserve status and be preserved indefinitely; e.g., White Bluffs and Old Hanford Townsite.

Apart from classification of the plant communities as indicated above, several other important classes of information are needed. These are needed also under the Biosphere Reserve concept, in order to use data effectively for baseline (reference) purposes. These ancillary needs have been met to a large extent on the ALE Reserve (5). Specifically, soil has been typed, chemically characterized and mapped; microclimatic variations have been measured and mapped over the past decade; an accurate history of prior disturbance has been established; vertebrate and, to a lesser extent, invertebrate fauna have been characterized; and the geology of the site has been established. Of these features, perhaps most useful to the ecologist has been the microclimatic mapping (8) and soil characterization (5) made possible by cooperating members from atmospheric sciences and soil science departments of the Pacific Northwest Laboratory. Where possible, baseline research as envisioned under the Biosphere Reserve concept can be greatly strengthened if there exists nearby multidiscipline capability, which may be called upon to put together an integrated team.

Below I have summarized objectives as outlined to us in the directive establishing the Hanford NERP, by Dr. James A. Liverman, Assistant Administrator for Environment and Safety, ERDA. Of the 12 objectives specified, the 7 starred objectives are well underway on the ALE Reserve and are appropriate to that location. Four of the remaining 5 objectives are more appropriately carried out at other locations within the Hanford NERP. In particular, demonstrations of alternative uses of land seem to me inappropriate for the ALE Reserve, or, for a Biosphere Reserve.

NERP OBJECTIVES

A. Establishing Baselines

* Characterize landscape components
* Establish field laboratory repositories ("preserves") for seedstock, plant types, and communities of organisms
* Develop quantitative methodology for measuring population and system changes
* Compile the ecological data base ("data center"); monitor for long-term changes

B. Determining Response to Man-made Disturbance

* Manipulate ecosystems in designed experiments
* Measure successional events, changes in habitat, or loss of key species

Study multiple interaction events; e.g., chemical stressors acting on the environment

C. Predicting Systems Change

* Build models for organizing knowledge of local ecosystems

Develop estimation techniques for assessing effects in absence of full-life history on key organisms

Correlate successional events with residuals affecting the ecosystem

D. Demonstrating Environmental Management Principles

Develop areas to publically demonstrate the long-term amelioration of ecological effects with costs of alternative options

Demonstrate alternate uses of land

WHAT ARE THE MAJOR PROBLEMS IN PROTECTING THE LAND?

In developing the ALE Reserve, we have found five points to be very important:

- Geographical Identity - this should also be ecologically meaningful, e.g., a natural watershed area
- Buffer Zones
- Special Policy on Fire Control
- (Strict) Use Control Policy
- Aerial Surveillance and Patrol

The idea of a Biosphere Reserve requires policing to ensure both the security of preservation areas and the integrity of experimental sites. This can be a very complicated problem since each of the points above are at times related. However, we have found that an aerial patrol flying 5 to 7 days per week maintains adequate policing, with only rare need for foot patrol or armed patrol.

Persistent pressures at Hanford have come from cattlemen and hunters who cut our fences to trespass, and from myriad civic groups wanting to use the ALE Reserve for their own purposes (hiking, photography, garden clubs, school outings, etc.). A fenced area, by itself, is little assurance against trespass, particularly if the region has no distinct geographical identity. If the area is large, as is the ALE Reserve (120 square miles), then the additional problem of patrolling can be unreasonably expensive unless means more efficient than foot patrol are used. There are also other disadvantages to foot patrols because we have to maintain a delicate balance between actual force and threat.

Trespassers are almost always local citizens. If their perception is one of being unfairly or too severely treated for trespass, unfortunate consequences have been known to occur. Our fear is of brush fire deliberately ignited by an irate citizen--something which has happened across the river outside Hanford often enough to be a constant concern. An aerial patrol avoids confrontations at the same time that it provides visible evidence of constant policing. Cattle trespassing through fences deliberately cut constitute special problems; this may be a uniquely Western problem. Therefore, cattle removal is done by a local rancher, under contract to us, who has suitable equipment for this purpose. Since instituting overflights however, this has been a minimal problem. We have maintained over the years records on the number of intrusions and our patrol can usually identify vehicles, number of people, and cattle. We find that intrusions decline in proportion to the number of weekly overflights.

The matter of buffer zones can be difficult. Here, again, we are mainly concerned about fire. We have dealt with this problem with the help of the local ERDA office. ERDA has facilitated exchanges of small parcels of land such that a dry-land wheat farmer now owns most of the land along the long southwest border of the ALE Reserve. Since the farmer's own interests are at stake--we have a common reason to exclude trespassers--he protects us on the south as we protect him on the north. The arrangement has been quite practical.

Civic groups and others wanting recreational use of the ALE Reserve have been controlled by having a firmly declared policy specifying the purposes for which people may enter the ALE Reserve.

Basically, access to the ALE Reserve is restricted to all but persons engaged in bona fide scientific work and maintenance personnel properly instructed as to disturbing the land. Additionally, in the interest of good

public relationships, we admit other visitors from time to time on a personally escorted basis. Since such visits can significantly tie up the time of our scientific staff, we try to keep them confined to one or two times each year. Visitors must be escorted, in our experience, otherwise rather ill-considered actions sometimes follow; e.g., killing snakes, digging holes (which may act as pit-traps), disturbing instrumentation arrays, etc.

For remaining portions of the Hanford NERP, apart from the ALE Reserve, we believe a similar use policy can be implemented. This matter is currently under discussion with the local ERDA office and will be resolved shortly. One point to keep in mind, however, is that there needs to be clear understanding about landlord responsibility when extramural people use the NERP. Not all areas of the Hanford NERP lie within Battelle's contractual responsibility to ERDA. Those areas may remain the responsibility of ERDA or of another contractor.

A remaining matter of policy concerns firefighting practice. This has been troublesome, over the years, as regards preservation of pristine sites within the ALE Reserve. Firefighting practice is usually decided by a fire department in biosphere reserve locations. Firefighting practices should be reviewed and they should reflect particular geographic and ecological considerations. At Hanford, for example, past experience has shown that fires at elevations above 1,200 feet on the ALE Reserve have very little lasting impact on vegetation and wildlife. However, the bulldozer marks and new roadways constructed during firefighting operations leave tracks on the landscape that persist for decades. With due regard to potential harm to government property and personnel, we believe that fires as they occur above 1,200 feet should be controlled at the 1,200 foot road and along the outer boundaries of the Reserve; i.e. no equipment should leave the existing roads. Also plain water and not borate should be used when spray planes are required.

WHAT HAS TO BE DONE TO ENSURE LONG-RANGE SCIENTIFIC INTEGRITY OF THE NERP?

In answer to this question, I see four goals that still need to be met at Hanford, for example:

1. Objectives for different regions of the NERP must be clarified and delineated.

2. A policy for technology facilities built on the NERP must be established on a compatible basis with preservation objectives.

3. Legislation is needed to clarify the legal and administrative status of the NERP.

4. Provision must be made for long-term ecological monitoring.

The first goal deals with both scientific and technological issues, at Hanford. It is clear that preservation objectives and the construction of a technology facility are not mutually compatible on the same square mile piece of real estate. Our industrial sponsors frequently misunderstand this point, if only because local impacts may be slow in appearing or because they may be partially ameliorated by special effort. The Hanford NERP, as discussed at an earlier point, is actually large enough to accommodate both objectives, provided they are situated at appropriate locations. At least that has been our experience with the nuclear energy facilities. The second goal is related and was also discussed at an earlier point. What is to prevent the future decision to install perhaps 3,600 MW of generating capacity using coal-fired steam electric plants on the large Hanford site? Both fossil and nuclear energy development responsibilities rest with different components of ERDA. In my judgement such a decision could have real ecological impact in an area that presently meets EPA's stringent air and water quality standards, an area that shows no significant environmental impact from nuclear facilities. When a unique ecological reserve exists, as it does here, meeting all criteria for a biosphere reserve, it would seem to serve ERDA's best interests to restrict development on the Hanford NERP to clean technologies. In my opinion, this ought to be a matter of declared agency policy.

On the third goal, I believe that long-range integrity is tied closely to the fate of the present ALE Reserve, which is already dedicated to Biosphere Reserve Program objectives. If the Reserve is to serve for baseline monitoring purposes, against which we may gauge landscape changes at similar disturbed sites nearby, then it requires a stronger degree of protection than is presently within ERDA's or Battelle's capacity to ensure.

As I stated earlier, the ALE Reserve was originally set aside as a buffer zone for the nuclear reprocessing plant. While we have enjoyed full support from ERDA, and AEC before it, to maintain integrity of the Reserve, its legal status is unclear so long as it remains solely a matter of agency declaration. If, for example, the nuclear waste materials buried at the Hanford site were removed to another location, I doubt that ERDA could withstand pressures from urban and agricultural interests to convert to other land use. Several years ago, for example, we were forced to allow use of three or four thousand acres of land on the northwest corner of the ALE Reserve by a vintner, for growing grapes. Recently, the regional cattlemen's association has requested that ERDA allow grazing on portions of the ALE Reserve during the recent northwest drought. Also recently, we have had requests to allow off-road vehicles to use the Reserve, and we have had trespass by unauthorized persons from a commercial land development firm who were scouting for water on the Reserve. While I believe such requests would be declined by ERDA, they are indicative of public pressure.

More difficult to deal with are interagency pressures. The General Services Administration (GSA) several years ago insisted on the sale of a strip of land on the southeast border of the ALE Reserve, which ERDA had been regularly leasing to a dry-land wheat farmer as a buffer zone. Eventually, this piece of land was ceded to the Washington State Department of

Fish and Game, who in turn leased it to the County of Benton for use by recreational vehicles. The potential for uncontrollable brush fires was so great that the State eventually agreed to rescind its agreement with the County, after strong argument by our staff. This land would have been better managed it if had remained under ERDA control; however, the concept of such a buffer zone was not recognized by GSA. In another matter pending, Bonneville Power Administration has asked for a power transmission strip along the southwest border of the ALE Reserve. The strip would impact 50 acres of a bitterbrush-sagebrush plant community only 100 acres in extent on the ALE Reserve. While there are other bitterbrush locations on the Hanford NERP, they lie in areas not subject to preservation objectives. We, of course, lose any time another agency compares its cost/benefit data. For example detouring a power line, against our 15-year research costs reckoned proportional to 100 acres out of 77,000 acres. In this way, the Reserve could be readily nibbled away, 5,000 acres at a time! On the larger Hanford NERP, similar problems often have been faced. ERDA has had to give up portions of Wahluke Slope, on the north, to the Bureau of Reclamation; and other areas, on the northeast, to the Washington State Department of Fish and Game. These slope areas were part of the natural watershed shown in Figure 2. In my judgment, management by the other agencies of these areas adjacent to Hanford NERP has been considerably less than satisfactory. Richland Operations Office of ERDA should be consulted on details, but my examples are sufficiently indicative of the problem of dealing with other Federal agencies. Because of these problems, primarily, I believe a legislative mandate is necessary to assure long-term integrity of the NERP sites.

Remaining matters possibly affecting legal status of the Hanford NERP concern unused easements and mineral rights. These are matters which also should be discussed with the ERDA's Richland Operations Office. I am not aware of any such rights presently outstanding on the ALE Reserve, but it is not clear how the rest of the Hanford NERP may be affected. In any event, rights such as these may be appropriately negotiated or purchased outright by the government, if any remain outstanding. Such rights would not appear to stand in the way of legislatively establishing the NERP or other biosphere reserves.

Since a NERP has different objectives than a national park--objectives which lie close to those for a biosphere reserve--it is important the *long-term* ecological monitoring programs be established, as indicated above as the fourth goal. This was done many years ago at the Hanford NERP. However, it is becoming progressively difficult to continue these kinds of effort as pressures within ERDA tend towards a narrow application focus for the research programs. As discussed earlier, one such study, on the Canada goose, proved valuable in documenting the preservation of normal environmental quality during the years of nuclear reactor operation. Other similar studies still underway are indicated below:

LONG-TERM ECOLOGICAL MONITORING
(HANFORD NERP-RELATED ONLY)

STUDIES--25 YEARS AND OVER

- Movement of Radiostrontium and Radiocesium in Old Abandoned Fields
- Nesting and Reproductivity of Canada Goose
- Susceptibility and Virulence Changes in the Synecology of Columnaris Disease (Fish)
- Succession in Old Fields - Suppression of Alien Weeds and Small Mammals

STUDIES--5 to 10 YEARS

- Micrometeorological Mapping of ALE Reserve
- Plant Succession at Burned Sites
- Salmon Redd Counts in Columbia River System Under Managed Hydro Regimes
- Baseline Organic Production and Carbon Flow Pathways Before and After Climatic Stress (Desert Steppe-Shrub Ecosystem)
- Avian and Raptor Census
- Home Range of Small Animals

STUDIES--3 to 5 YEARS

- Vegetative Recovery After Controlled Grazing
- Blue Heron Habitat
- Coyote, Mule Deer and Elk--Herd Size and Range

The work above represents less than 10% of our research budget in the ecological sciences, but we are under great pressure to justify its continued existence. Wading into the Columbia River in hip boots to sample fish for the Columnaris bacterium, classifying grasshoppers and exotic beetles, or counting Canada goose eggs may appear very frivolous to the uninformed taxpayer, to the biomedical scientist, or to the engineer on the technology side of ERDA. Yet, I am sure, members of this Subcommittee will recognize that these procedures may provide key data for gauging the seriousness of environmental impact, when it occurs. If NERPs are established by legislation, I then, believe that long-term ecological monitoring should be distinguished from other research needs by similar legislative action.

KINDS OF LONG-RANGE RESEARCH APPROPRIATE TO NERP OBJECTIVES

Traditionally, biological scientists have approached effluent releases from a laboratory viewpoint, using selected plant or animal species as biological indicators, and identifying substrate and tissue concentrations of various materials needed to induce death or impair normal function. This is essentially a piecemeal approach, which gives little, if any, information on holistic performance of ecosystems. These approaches, in fact, represent the largest portion of present funded work in our laboratories and elsewhere.

Long-term ecological monitoring is needed. Long-term ecological monitoring also needs to be distinguished from monitoring for present licensing requirements for standards of the Environmental Protection Agency. The latter efforts are not adequate to detect long-range changes. This is obvious by statistical evaluation of current assessment methodology. Certain kinds of adverse impact can be forecasted even for the 10-year, 20-year, or 30-year build-up situation based on modeling and indicators of early response (7). For the energy technologies, lead time is needed to allow modifications. Ignoring the long-term build-up situation and relying only on present standards could lead to costly retooling, for example with new energy installations. The historical record of Western development amply illustrates this mistake (10).

Pollutants from different sources are often found to cause specific types of damage; e.g., changes due to smelting, urban oxidants, or aluminum ore reduction can be differentiated from presumptive changes due to coal combustion. Sampling design is critical; e.g., dose relationship to plant proximity must be established, in addition to species and specified damage. This is the environmental analogue of epidemiological studies for human health purposes.

Negative data can be extremely valuable for environmental impact judgments, *but only if sampling is carefully designed to test a meaningful hypothesis*. Much of current pre- and post-operative monitoring is now discredited (9); from the standpoint of statistically controlled design, it is insensitive. Also, the usual question is meaningless: "Is there any effect on the ecosystem?" (there often is, but it may be unimportant). The meaningful question depends on knowledge of what is important or unique in a particular system--Will the salmon fishery be impacted? Will grazing productivity of this grassland be impaired? Will an endangered or threatened

species at that site be knocked out? As not all such questions are obvious, one must depend on descriptive ecologists who have strong experience in the region in question.

Methods may require streamlining, based on knowledge of the specific ecosystem; they likely cannot be prescribed generically. Ecologists have done a poor job on setting sampling priorities. Also, they have been *required,* too often, to measure too many species, construct insensitive diversity indices, and follow sampling designs that are inadequate. In a terrestrial environment, it may be far more important to get a handle on an important habitat change, or on primary productivity; in an aquatic environment, it may be more important to track the life history and reproductive success of only one or two valued species. In both cases, measurements should be followed on an adequate statistical basis over a substantial period of time; e.g., 5 to 10 years, including several preoperational sampling years. Some of the most valuable data for impact assessment purposes have represented comparatively simple determinations, carried on for as long as 25 years.

In terrestrial ecosystems, we currently need to know whether greatly increased burdens of airborne metals and organic compounds anticipated with the development of coal technology will lead to slow deterioration of forest, agricultural, or other terrestrial productivity. Predictive modeling is needed, not as an end in itself, but rather as an adjunct for evaluating the importance of individual organism sensitivity to projected burdens (plant, animal, or microbial). For definitive answers, landscape "manipulations" are required that may involve experimental watersheds of several hundred acres. Systems structural or productivity changes will be the key variables. Manipulation of the environment may be achieved in several ways, including comparisons before and after the startup of an industrial facility.

In aquatic environments, we need to know at what point pollutant burden damages either organic productivity or ecosystems structure sufficiently to render such bodies of water unsuitable either for visual esthetic or recreational purposes. Despite a good many years' research since NEPA, we often do not know the ultimate receiving capacity of lakes or other bodies of water for energy residuals as magnitude of operation is scaled up. The answers to these questions cannot be predicted from water quality measurements alone. Three types of approaches are required to answer these questions: 1) laboratory studies to establish the case for synergistic action of several pollutants on reference organisms, 2) systems data from designed intermediate-scale aquatic ecosystems subjected to effluent perturbation, and 3) studies based on modeling to predict intermediate scale system effects when scaled up to the size of natural bodies of water (which it would be infeasible to directly pollute). In addition, food chain data may be required, but the latter are for biomedical concerns not primarily environmental impact concerns.

Thank you, Mr. Chairman, for this opportunity to express my views on Federal research reserves.

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BIOGRAPHICAL BACKGROUND

BURTON E. VAUGHAN
Manager, Ecosystems Department
Battelle, Pacific Northwest Laboratories
Richland, Washington 99352

EDUCATION

A.A.		University of California Berkeley	1947
A.B.	Physiology	University of California Berkeley	1949
Ph.D.	General Physiology Biophysics, and Radiation Biology	University of California Berkeley	1955

EXPERIENCE

Dr. Vaughan has maintained a broad interest in biology dating from undergraduate training at Berkeley. Graduate studies were split between biophysical studies at Donner Laboratory and more extensive environmental studies at White Mountain High Altitude Research Stations and in the Antarctic (McMurdo Sound). His published work has covered radiation biology, plant physiology, mammalian physiology, and ecology. He has also served on the teaching faculty of Stanford University; and more recently, as an affiliate (associate) professor of radiology at the University of Washington. Dr. Vaughan has published about 51 papers in reports and journals of national scholarly societies of which he is a member.

At an administrative level, Dr. Vaughan has been directly responsible for the mission and performance of ecological research at Battelle's Pacific Northwest Laboratories, where he is Manager of the Ecosystems Department. Under his direction, a broad spectrum of ecological and environmental research has been developed through support derived from a number of Federal agencies and industrial groups (ERDA, NIH/NIEHS, U.S.A. Army Corps of Engineers, Bonneville Power Administration, NOAA/BLM, Electric Power Research Institute, American Petroleum Institute, EPA and others). These include programs on the environmental behavior of transuranic elements, the dynamics of arid landscapes, land rehabilitation, the ecology of heavy metals, marine and freshwater pollution effects, theoretical biology, sampling theory, and food-chain pathways.

Outside professional activities, Dr. Vaughan has been very active in public school affairs, serving on several Boards of Education in the California school system. He is currently active in museum exhibit and public education activities as a trustee of the Pacific Science Center Foundation in Seattle and Chairman of its Science Council. Dr. Vaughan has had an abiding interest in music, being especially active over the past six years in a chamber music sponsoring society.

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Mr. BROWN. Next, we have a panel of three representatives from the Department of Interior and I would like to ask all three of you gentlemen to come up—Mr. Marcus Nelson, who is Chief of Division of Wildlife Refuges; Dr. Theodore W. Sudia of the National Park Service, Chief Scientist; and Mr. James W. Monroe, Bureau of Land Management.

Now each of you gentlemen represent important bureaus which have extensive responsibilities in this area, and we appreciate your willingness to spend some time with us this morning and help to put this matter in a little better perspective for us.

You may proceed in the order in which I listed your names if you wish, or if you have any prepared order you may follow that.

Do you want to start off, Mr. Nelson? Your full statement will appear in the record and you may proceed to read it if you wish or summarize it.

STATEMENT OF MARCUS C. NELSON, CHIEF, DIVISION OF WILDLIFE REFUGES, U.S. FISH AND WILDLIFE SERVICE

Mr. NELSON. I appreciate the opportunity to appear before you today and discuss the role of the U.S. Fish and Wildlife Service in wildlife research on lands administered by the Service.

The overall mission of the U.S. Fish and Wildlife Service is broad in scope and diverse in character. It ranges from the protection and management of continual waterfowl populations to providing assistance to inner city residents in nuisance bird control; from the maintenance of the anadromous fishery to the control of importations of endangered wildlife species.

Research is essential to determine the basic requirements of different species, the interactions of wildlife species with each other and with their habitats, the effects of human activities upon wildlife, and the human needs that are fulfilled by wildlife. Our research centers around waterfowl management, other migratory birds, wildlife ecology on public lands, pesticide-wildlife relations, diseases and parasites, animal damage control, life history studies on birds and mammals, endangered species, and foreign wildlife investigations.

The majority of Fish and Wildlife Service land lies within the National Wildlife Refuge System. The System includes over 32 million acres in 384 units in 49 States and 8 territories. I would like to add one more note that is not in my paper—the Wildlife Refuge System was begun in 1903 with the acquisition of Pelican Island off the east coast of Florida. Probably the System's greatest period of growth was in the 1930's.

Although research is not the highest priority on refuges, it is an important objective and supplies facts necessary in making management decisions.

Mr. BROWN. Mr. Nelson, may I interrupt you just a moment to clarify your statement about the acquisition of land.

Do I understand that all of this land is held in fee—that it is owned, in other words?

Mr. NELSON. No, it is not, sir. We have about five kinds of land.

Mr. BROWN. All right, does your statement go into that later on?

Mr. NELSON. It does not describe them. I can very quickly do it.

Lands acquired in fee title, either purchased or donated.

Land acquired by withdrawl from public domain.

Land administered under cooperative agreement with another Federal or State land-owning agency.

Land set aside by special Executive order.

Less than fee interest lands.

There may be other arrangements, but those are the major ones.

Mr. BROWN. The Bureau has effective control over all of them regardless of the type——

Mr. NELSON. Yes, sir, but subject to primary jurisdiction, in some cases, by the owning agency.

Mr. BROWN. All right. Thank you.

Mr. NELSON. Although research is not the highest priority on refuges, it is an important objective and supplies facts necessary in making management decisions. Service policy encourages and supports wildlife oriented research on units of the system.

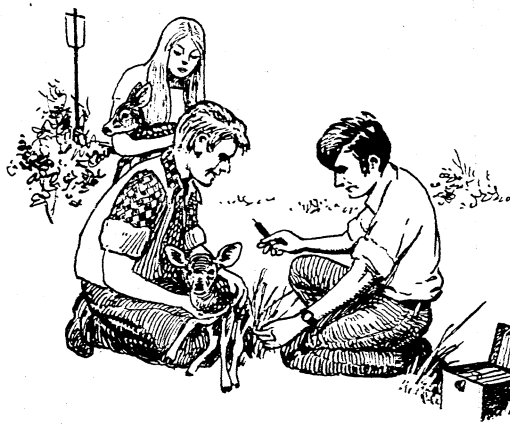
Refuge lands, water, and facilities may be used for research by non-Service entities when this research does not conflict with other refuge programs or responsibilities of greater value or priority. Studies designed to help resolve wildlife management problems of individual refuges, or of the refuge system as a whole, are especially encouraged.

All research or study proposals to be conducted on refuges must be approved by the refuge manager to insure that due consideration is given at the resource level to biological, social, and economic aspects of the study, and that potential conflicts with other programs are recognized and resolved. A publication, "Research Opportunities in the National Wildlife Refuge System," is available if anyone would like it. I would be pleased to supply copies.

Mr. BROWN. We would like to have a copy for the record if you do not mind.

Mr. NELSON. I would be glad to.

[The publication follows:]



RESEARCH OPPORTUNITIES IN THE NATIONAL WILDLIFE REFUGE SYSTEM

DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service

The National Wildlife Refuge System is composed of 378 National Wildlife Refuges and 20 Wetland Management Districts, totaling 34,136,101 acres. These areas are managed by the Fish and Wildlife Service of the U.S. Department of Interior and represent unique opportunities for wildlife and wildlands-oriented research. The purpose of this publication is to describe some of the types of areas to be found, objectives and research needs of the refuges, and procedures to be followed in obtaining approval to conduct field research on them.

A wide variety of biomes is to be found within the National Wildlife Refuge System. Southwest desert, arctic tundra, coastal rain forest, prairie pothole, timbered swamplands, eastern hardwood forest and estuarine marsh are but a few examples. Most of the refuges encompass wetlands supporting large numbers of waterfowl, but some have been set aside to preserve habitat for threatened species; yet others concern themselves with ungulates once endemic to large areas of the continent, and still others with colonial nesting sea birds.

Objectives of the National Wildlife Refuge System

The National Wildlife Refuge System's mission is to provide, manage and safeguard a national network of lands and waters sufficient in size, diversity and location as to meet people's needs for areas where the entire spectrum of human benefits associated with migratory birds, other wild creatures, and wildlands are enhanced and made available. To meet this overall mission, the system is concerned with perpetuation of endangered plant and animal species, supporting populations of migratory birds at desired levels, demonstrating wildlife and wildlands management practices, and expanding an understanding and appreciation of wildlife and wildlands ecology. The System contains a mosaic of wilderness areas, research natural areas, and lands and waters where vegetation is manipulated through various management practices. Providing wildlife diversity is an important consideration. Surplus refuge animals are often removed through public hunting. Historical, geological, archeological, and other scientific sites are given special consideration. The role of refuges in providing an ecological monitoring service to the nation has a high priority.

Research Needs and Support

Especially encouraged on National Wildlife Refuges are management-oriented research projects or studies which will lead toward solving management problems of individual refuges or the System as a whole. Refuge managers in charge of each area are aware of their research needs and can inform potential researchers of the most important needs. Research Natural Areas have been established on many refuges to provide unique habitat types to be used primarily for research purposes.

The Fish and Wildlife Service seldom provides funds for research projects conducted by non-service personnel on refuges. Funds are supplied only for critical refuge management problems and for these studies, the Division of Wildlife Refuges of the service sometimes has contracts with Cooperative Wildlife Research Units located on various college campuses or with universities having expertise in the area of concern. The Refuge System may, however, provide sites and coordinate research on refuges.

One of the objectives of the National Wildlife Refuge System is to allow people to appreciate and receive enjoyment from wildlife resources. Some of the System's most critical research needs involve people and avoidance of conflict between people and the resources they come to enjoy and study. Therefore, studies on determining compatibility between public uses and wildlife use are among the most critical needs at present. Refuge objectives are developed according to demands and capabilities on a sustained basis, and developing means for avoiding conflict between objectives is a challenge. There is a need not only to better define the capacity of individual refuges for various types of public uses but also for more information on anticipated demands for the years ahead. Maintaining quality in the public use program is paramount. Some examples of needed studies include quality versus quantity waterfowl hunting demands and capabilities; design and location of self-guided nature trails and auto tour routes; maintenance of threatened or unique non-game species in harmony with game species and public use; manipulation of vegetation to maintain desired plant succession for key wildlife species; and aquatic vegetation distribution, density and succession as related to water levels, soil and water chemistry, muskrats and grazing.

How to Obtain Permission to Conduct Studies on Refuge Lands

Individuals wishing to conduct research studies on individual refuges are invited to make direct contact with the Refuge Manager. Among the requirements to conduct research on a National Wildlife Refuge will be a study proposal in the following format:

1. Title of study (state concisely).

2. Objectives: (number each objective, defining it clearly and concisely, limiting each statement to a goal of possible accomplishment.)

3. Justification: (outline extent of knowledge and background; describe briefly how the study will contribute to better management of the area or its importance to other fields.)

4. Procedure:
   a. Literature review.
   b. Data collecting (cover techniques and location of activities; describe any markers, structures, or other material to be placed on the refuge and affirm that such material will be removed by the investigator; describe in detail any capture, markings, or tagging techniques. Be sure to cover who is to do what, when, where and how.)
   c. Data analysis and interpretation.

5. Cooperators: (List other participating institutions, agencies, organizations, or individuals, if any.)

6. Responsibility: (Set forth work and supervision responsibilities.) Indicate role to be played by the refuge, especially anything in addition to providing the study area.

7. Cost: (Costs, if any, to the Service should be broken down by fiscal year and include man-years, equipment, supplies, etc., to accomplish the study.) Most studies will not involve any direct costs to the service. Financial support for the study should be clearly indicated.

8. Schedule: (Estimate starting and completion dates. If a portion of any given study is to be accomplished separately, the recommended starting and completion dates of each phase should be shown.)

9. Reports: (Establish due dates for progress and final reports and indicate the number of copies to be furnished to Refuge Manager.) When Service funds are involved reports will be furnished the Refuge Manager for the Regional, Area, and Washington Offices.

10. Publications: (State plans, if any.)

11. Submitted by: (If student study, major responsible professor should also sign.)
Date:

12. Approvals:

A. When Service Funds not involved,

(1) Refuge Manager Approval _____
Date

B. When Service Funds involved,

(1) Refuge Manager approval _____
Date

(2) Regional Office, Refuges, approval _____
Date

(3) Research Division, review by _____
Date

(4) Regional Director approval _____
Date

The Refuge Manager may require additional information over and above the proposal such as entry and registration, vehicle licenses, permits etc. The marking, collecting, capture and other activities must be in accordance with state and federal law.

Whom to Contact

Further information may be obtained from a Refuge Manager, or by writing a Regional Director, U.S. Fish and Wildlife Service, with one of the following addresses;

REGION 1 – P. O. Box 3737, Portland, Oregon 97208
(California, Idaho, Hawaii, Nevada, Oregon, Washington)

REGION 2 – P. O. Box 1306, Albuquerque, New Mexico 87103
(Arizona, New Mexico, Oklahoma, Texas)

REGION 3 – Federal Building, Fort Snelling, Twin Cities, Minnesota 55111
(Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin)

REGION 4 – 17 Executive Park Drive, N.E., Atlanta, Georgia 30329
(Arkansas, Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee)

REGION 5 – John W. McCormack Post Office and Courthouse, Boston, Massachusetts 02109
(Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia)

REGION 6 – 10597 West 6th Avenue, Denver, Colorado 80215
(Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming)

ALASKA – 813 "D" Street, Anchorage, Alaska 99501

DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service
January 1976

Mr. NELSON. During 1976, 392 studies were conducted on 129 refuges. Of these, approximately 68 percent were conducted by non-Service people.

National wildlife refuges are protected by law, and additional legislation to insure long-range protection of sites now available for research is not necessary. In addition, further protection is afforded sites administratively designated as Research Natural Areas or legislatively designated as part of the National Wilderness Preservation System.

In response to growing national recognition of the need to preserve natural environments and ecosystems, the Service is cooperating with other Federal land managing agencies in the identification, classification, and establishment of Federal natural areas.

The National Wildlife Refugee System has 181 Research Natural Areas on 88 National Wildlife Refuges. Research Natural Areas on refuge land may be as small as a few acres or as large as several thousand, depending on the ecosystem they represent. These areas, set aside for scientific and educational purposes, total nearly 2 million acres within the refuge system.

In the U.S. Fish and Wildlife Service, a Research Natural Area is an area where natural processes are allowed to predominate. These areas may include typical or unusual faunistic and/or floristic types, associations, or other biotic phenomena, or characteristic or outstanding geologic, pedologic, or aquatic features and processes.

Research Natural Areas provide important baselines against which man-caused changes can be measured. They are useful for evaluating the improvement or impairment resulting from the intervention of man in the otherwise natural environment. The urgency for setting aside and protecting these areas becomes greater as our expanding population increases our demands on the land; as our concern for soil, water, and atmospheric pollution grows; and as far-reaching environmental controls, such as weather modification, become a reality.

In many cases, Research Natural Areas and other refuge lands have been further protected by the designation of a wilderness. These may be protected from encroachment by fences or signs, but normally the unobtrusive character or isolated location of these research natural areas offers adequate protection. Research on these areas must be nondestructive and reasonably consistent with the purpose and character of the surrounding land.

Studies that require manipulation of the environment are normally done elsewhere. Scientists and educators are encouraged by the Fish and Wildlife Service to use these areas. Restrictions are applied only to preserve the natural values of the area and to protect any research projects already underway. A written permit is required, and a summary report must be submitted upon completion of a research project.

Biosphere Reserves, which I think you will talk about tomorrow, have been established on two National Wildlife Refuges—the San Andreas National Wildlife Refuge in New Mexico and the Aleutian Islands National Wildlife Refuge in Alaska. They were designated by the International Coordinating Council of UNESCO. These areas conserve specific biotic communities and provide opportunities for baseline ecological and environmental research.

In addition to the National Wildlife Refuge System, the Service maintains lands in the National Fish Hatchery System and at wildlife research centers. Fish hatchery lands are not generally useful as environmental research reserves, since the land and water is developed primarily to provide controlled environments for fish propagation and fishery research. Lands associated with the research centers, although well protected and necessary to wildlife research, are not classified as environmental research reserves, and would not benefit by having their flexibility to accommodate a variety of controlled research projects impaired. It may be of interest, however, that at the Patuxent Wildlife Research Center over in Laurel, Md., over 2,000 acres have been maintained in a natural state for many years prior to acquisition by the Service. Since 1944 long-term ecological research has been conducted by the Service on this tract which today is rather unique in this part of the country. While most of the research is in-house, the area is available for approved studies by other Federal agencies, universities, and independent researchers.

In conclusion, Mr. Chairman, I believe that insofar as Fish and Wildlife Service lands are concerned, adequate authority exists for the U.S. Fish and Wildlife Service to preserve and protect the lands and waters under its jurisdiction as natural areas and to make such areas available for useful and desirable research.

This concludes my prepared statement. I appreciate the opportunity.

Mr. BROWN. Thank you very much, Mr. Nelson. I think that gives us a good picture of what your Service is doing in that field.

Next, we would like to hear from Dr. Sudia, Chief Scientist, National Park Service.

STATEMENT OF DR. THEODORE W. SUDIA, CHIEF SCIENTIST, NATIONAL PARK SERVICE

Dr. SUDIA. Mr. Chairman, it is a privilege for me to appear before you to discuss environmental research networks. This program is of great interest to the National Park Service since the use of parks for scientific purposes, including environmental education, research, and monitoring, is part of the basic mission of the National Park Service.

It is the policy of the National Park Service that inasmuch as:

> Natural and social science information is necessary for the management of the National Park System; the National Park Service will conduct a program of natural and social science, for the purpose of supporting management in carrying out the mission of the service by providing decision assistance in all aspects of planting, development, and management of the units of the system.
>
> The Service also encourages the use of parks by others for scientific studies when such use shall be consistent with the purposes for which the parks were established.

The entire system of national parks, monuments, and recreation areas serves as a network of research reserves which are protected in perpetuity, in accordance with the Organic Act of August 1916, which calls for the parks to be maintained "unimpaired for future generations."

The annual report of the Chief Scientist of the National Park

Service for 1975 lists 1,271 natural and social science projects which were ongoing in the park system during the calendar year.

Research in the parks is conducted by Service as well as nonservice scientists and falls into the following categories: research on animal species, geology, plants and vegetation, general ecology, freshwater biology, human impact, marine studies, hydrology, sociology, fire ecology, meteorology, and other miscellaneous topices.

In general, independent investigators tend to work in parks where strong Service-supported research is going on, partly because of the information base available for their own studies and partly because of the enhanced capability for logistical support available in parks with strong research programs.

Service-conducted research in the National Parks is performed to support the basic mission of the parks as outlined in the general management plan for the park, the park's statement for management, the resources management plan, the interpretative plan, and the visitor use plan.

Research in the parks is aimed at resource preservation and management, interpretation of the parks to the visiting public as a means of enhancing visitor experiences in the parks. For the most part, the enabling acts establishing the parks call for the preservation of the natural values of the parks, by generally calling for the maintenance of the park in its natural condition. This is interpreted in the management policies of the National Park Service to mean the management of the parks to maintain the natural ecosystem processes which in turn produce and the wonders and curiosities for which the parks are notable.

The current efforts in the natural landmarks program of the National Park Service are to identify outstanding natural areas in all the physiographic provinces and vegetation types of the United States for possible recognition as national natural landmarks or for recommendation for inclusion in the National Park system, in accordance with the General Authorities Act of 1976. If the process of rounding out the park service were to continue, parks should eventually be established in every major physiographic province and vegetation type of the United States.

The National Park Service is a participant in the UNESCO Man and the Biosphere program and cooperates with many Federal agencies, universities, and other research organizations for the performance of research in the national parks.

Mr. Chairman, I would like to just add as a footnote an explanation of the two documents that I brought along which certainly need not be included in the record but which might be of interest anyway.

Part II of the National Parks System Plan is the recipe by which the national landmarks program works and is at the present time examining essentially all of the physiographic provinces of the United States with the idea of locating outstanding areas to be either natural landmarks firstly, or secondly for possible recommendation as a National Park. This obviously is kind of a precursor to the study which is now going on at the National Heritage Trust and certainly if something comes out of the National Heritage Trust, it undoubtedly will be related to this function.

There is a map in the brochure itself which indicates the present coverage of the national parks, monuments, recreation areas, and so on, in the United States as a whole, and in general, the darker the green the better the representation, the lighter toward white, the poorer the representation, until finally the white itself is very little representation. So it goes without saying that we have a long way to go in getting adequate representation, but as the process is established the question of course is one of adequacy. Anybody that has been familiar with the attempts to establish a grasslands national park in the United States, recognized the great difficulty in simply saying, well, we want a million acres of this prime farmland.

The second document is the Annual Report of the Chief Scientist and will give you the flavor of both the kinds of research, the institutions who are conducting it, and the geographical extent. Some 80 or 90 parks have active research programs. Many of them, you might be interested to know, essentially are supported by almost entirely outside funding. Shenandoah National Park which is very close to us here in Washington has a very active research program very little of which is Service-supported. So there is a great deal of interest in universities and other organizations in working in the parks simply because there is some assurance that these areas will be available at another time to come back and see what may have happened as the course of the activities go on.

Mr. BROWN. We would like to have those documents for the committee file.

Dr. SUDIA. They have been made available to you.

That concludes what I have to say, Mr. Chairman.

Mr. BROWN. Mr. Monroe?

STATEMENT OF JAMES W. MONROE, ASSISTANT DIRECTOR OF LEGISLATION, BUREAU OF LAND MANAGEMENT

Mr. MONROE. Thank you, Mr. Chairman. It is a pleasure to be here and discuss what the Bureau of Land Management is doing in regard to environmental research reserves.

Mr. BROWN. Tell us what you are doing with all that desert land in California.

Mr. MONROE. Thanks to Congress, Mr. Chairman, that in its wisdom last year approved the creation of the California Desert National Conservation Area, we are moving out in a good program of land use planning and management of the California desert. It is a very competitive area as you well know. Special interests are competing with us for the use and some say destruction of the southern California desert, so we are doing our best with Congress help.

Overall the Bureau of Land Management is responsible for some 470 million acres of public land and its resources largely in the Western States, including Alaska. For many years, we have managed this land under the principles of multiple use and sustained yield. As I have mentioned, the Federal Land Policy and Management Act that is the parent legislative authority for the California Desert Conservation Area, solidifies and makes mandatory the principle of retention of these lands in Federal ownership to be managed for

multiple use and sustained yield. Of course, multiple use includes many of the things you may have referred to—off-road vehicle use, livestock grazing, mineral exploration, timber harvests, as well as the identification and protection of scenic values and other research or scientific values.

The lands are also very valuable as watersheds for many of the communities in the West.

We use the land use planning system which starts with a resource inventory by qualified biologists, recreation specialists and planners of all types—with all disciplines represented. We go into a land use planning program broken down into some 450 to 500 geographic areas or planning units as we call them.

The Federal Land Policy and Management Act, the so-called organic act of the Bureau, does require that we utilize the land use planning system to carry out the management function of the Secretary with regard to the public land. Of course, we also use the National Environmental Policy Act in our administration of the public lands.

Getting specifically to environmental research reserves, a number of years ago—largely in connection with the livestock management program—we established a number of exclosures, fenced areas, where nothing was allowed to enter. No impact by man or animals other than those that naturally occurred in the area. We were able to use these areas to build a base of knowledge, in a sense baseline monitoring, to allow some comparison as to what happens to those areas that were intensively utilized by livestock, those where there was good intensive management of livestock grazing, and the exclosures where there was no livestock intrusion allowed.

This obviously is a continuing program; over the years we have been utilizing the type of data that we have gathered from those areas.

Later, under authorities existing at that time, we started establishing Research Natural Areas and outstanding natural areas along with what we call primitive areas that were judged on the basis of their wilderness characteristics. The Bureau has established, or the Secretary has, 19 Research Natural Areas and 23 outstanding natural areas throughout the Western States.

Research areas are established for the primary purpose of research and study of the environment, some successional trends in the biological structure and other natural phenomena of scientific interest. They contain typical or unusual types of fauna and flora associations or other biotic phenomena. There is also some outstanding geologic or aquatic features or processes that have been identified and are being studied.

Outstanding natural areas possess scenic values and areas of natural wonder. Primary management objectives of those is preservation of those features in their natural condition. Some of the Research Natural Areas are Big Sage Natural Area, about 160 acres in Arizona; and the McElmo Reptile Natural Area, some 445 acres in Colorado.

One of our best known natural areas is the Snake River Birds of Prey Natural Area in Idaho, 26,000 acres of public land designated in 1971 to protect eagles, hawks, falcons, owls, and vultures. It attracts more nesting raptors than any other known location of similar size in North America and provides an opportunity for continued research and study.

Recently, in fact, we introduced the endangered peregrine falcon into the area, reintroducing it by substituting peregrine chicks for prairie falcon chicks. At last report they were doing very well.

Several thousand acres of adjacent Federal lands, while not included in the formally designated birds of prey area, are under use as a research area under controlled conditions against any intrusions that might come in so that we can discover the feeding patterns and distances the raptors travel in the birds of prey area. We found one hawk that is going out 14 miles to do his feeding. We use a lot of telemetry and scientific devices so that we can really track the bird.

The Bureau planning system necessitates continuing consideration of the impact of one resource use on all other resources in the given area. This again brings in the interdisciplinary approach. Then, of course, as required by the National Environmental Policy Act, if we have any action that is a major Federal action, such as the development of a coal mine and conversion of the coal to electricity, we must look at the overall cumulative impacts of this proposed action.

In the last year we did well over 10,000 environmental assessments under NEPA and initiated some 200 full Environmental Impact Statements governing all of the proposed actions that we are responsible for initiating ourselves plus those that are initiated by non-Bureau motion.

Also, under the Federal Land Policy and Management Act, we have direction in our inventory process to early identify areas of critical environmental concern. These could be areas where there may be natural hazards that require some work to protect the visitors or areas where we would just prevent any degradation at all of the resource. Or again, areas that may need some manipulation by man to restore them or to protect further from further degradation.

The Federal Land Policy and Management Act has a number of provisions that are discussed in the prepared statement. I will not detail those at this time but they do provide the mechanisms and the management tools for managing public lands.

The Federal Land Policy and Management Act does not apply to the Outer Continental Shelf, where the Bureau of Land Management is responsible for baseline environmental studies as well as the oil and gas leasing and followup environmental studies to that activity. Leasing is entirely discretionary and I believe adequate regulatory authority is provided under the present law and especially under the pending legislation in both the Senate and the House on the OCS Act amendments.

We do not feel any additional authority is needed to protect areas for environmental research on the Outer Continental Shelf.

We also are participating in the National Heritage Trust Proposal Development that Dr. Sudia and others have already referred to.

In summary, Mr. Chairman, we have taken some steps toward establishing a system of environmental research areas on public lands administered by the Bureau. Pursuant to NEPA, the Federal Land Policy and Management Act, and direction from the President and Secretary of the Interior we will continue to identify and designate these areas that are suitable for environmental research. Our current authority, we believe, is sufficient to accomplish these objectives as well as to protect the areas that are already established.

Thank you.

Mr. BROWN. Thank you.

Gentlemen, I presume that you were here earlier this morning and heard the testimony from the ERDA people with regard to their activities in this area. I am interested to know how you perceive the differences between what they are doing and the kind of research and the methods of organization that you have in each of your agencies, not only in terms of the nature and types of research being done, but also the nature and kind of resources applied to it.

The Oak Ridge and Hanford operations both seem to include a rather large number of professionals engaged in the ecological research, and I do not know whether your agencies maintain a comparable ecological staff or not, but I think that would have some bearing on the extent to which we are able to generate a flow of scientific information for these operations. Could you comment on that?

Mr. NELSON. I should like to comment for the Fish and Wildlife Service. I did not mention this in my statement, but you are probably aware of the fact that the Fish and Wildlife Service has a Division of Wildlife Research. They also have the Office of Biological Services, which was mentioned by one of the gentlemen who is also within the Fish and Wildlife Service.

Our recent Assistant Secretary, Mr. Reed, made a strong effort during his administration to establish the Fish and Wildlife Service as "the biological arm of Government." We are deeply involved in wildlife research in many areas and have been for many years. Probably the beginning of research in the Fish and Wildlife Service came about many years ago in the attempt to develop methods of controlling predators. It goes way back to when we were the Bureau of Biological Survey, back around 1930.

From our point of view, however, our research is designed primarily to further our capability of taking care of the migratory bird management program and the refuge land management program. Our research programs are related primarily to furthering our own responsibility, not necessarily to broadening some of the concepts that were mentioned this morning.

I was speaking to our own land management philosophy in my statement.

Mr. BROWN. Obviously, one reason that ERDA moved into this field is because their mission was to evaluate the impact of a new, strange, and to some degree fearful form of energy on human beings and the environment. So they undertook a very broad impact assessment program to see if they could evaluate these effects.

Your mission is not the same. Yours is, as you have indicated, to protect fish and wildlife and understand their interaction with the environment. That explains, of course, most of the differences in the way you operate.

I am still trying to understand the degree to which we are moving toward the kind of research, the broad gauged analysis of a complete ecological system, that ERDA was compelled to by the nature of their circumstances.

Mr. NELSON. May I add one more thing? We do overlap and we do work with, well, let us say, the long-term research programs in the

sense that we have been deeply involved in pesticides or pesticides monitoring. In this area we do get away from the wildlife factor. We move through the wildlife factor and the fish factor on into human relations.

Mr. BROWN. Could you just offer a brief comment about the approximate level of personnel that you could reasonably say are working on ecological research of the sort that we have been discussing here?

Mr. NELSON. Our research division includes—a rough guess off the top of my head right this minute—possibly 600 people.

Mr. BROWN. Dr. Sudia?

Dr. SUDIA. Mr. Chairman, let me see if I can address your question at two levels, one more general than the other.

I think, from the discussion earlier this morning and from some of the other things that are happening now, that one problem is the management of the land, and, in terms of these large sites ERDA is now managing for nuclear technology, that it is a land management problem with some overlying considerations. The primary thing is the nuclear technology. The secondary one is the effects of this development.

I think that this is a general problem. The question is one of managing land in such a way that the impacts to that land could be readily understood for whatever mission the land is dedicated. I think that in many cases what you will be able to see is that the difference in what happens to the land is either the mission or the agency or the purpose for which it was dedicated and that consequently determines what happens later. For instance, the Park Service's basic mission is to preserve large areas for recreation, pleasuring grounds, and so on.

We have to be very careful about the impact of development and we are more or less obsessed with this question of the impact of development, the encroachments of civilization, and the impact of people on these natural areas. We have devised a system, which is not fully implemented but which again is in process, of basic inventories of resources and a general planning process which takes into account the basic ecology/environmental considerations before any planning is done. This includes things such as the geology, the hydrology, the vegetation, the animal species, endangered species and so forth.

After the general management plan is done, then the park is constrained to follow resources management plan, interpreter plan, visitor use plan, where the management actions are going to be spelled out and the need for information is appropriately documented.

I think that if one were to look at the process without worrying specifically about the type of land dedication or the specific activity that was going on, you would see a great similarity between what ERDA is doing at its nuclear installations and what the Park Service is doing with parks and what I presume might be happening with the refuges and other areas that are managed by the Bureau of Land Management.

Another consideration, aside from the land managing one, is the appropriateness of research itself for these activities or for these purposes. I think in the first instance when one looks at the question of land management, this is a very finite problem. Land is going to be dedicated for certain purposes; we need a certain amount of information in order to carry out that objective.

Now, to go further beyond that point and to determine what the general effects are of some factor or what the ecosystem is doing at any particular time without reference to specifics, this very easily could become an open-ended type of research activity for which funding might increase logarithmically if unchecked.

Now, what we have essentially done is view our mission as that of the land manager and have utilized information necessary to do that, and by allowing the parks to be used in ways consistent with their purposes by anybody that wants to. We find that, for instance, two-thirds of all research that is done in the parks is done by investigators who are not Park Service people. We encourage this by a system of permits which allow people to work in the parks. We further encourage it by providing services in kind rather than in money, that is, logistical support—housing in some cases, transportation, safety considerations, the notion of rescue and whatnot. In some places where their work will be particularly hazardous, such as in the inner Grand Canyon where rescue might be essential, this support is guaranteed.

Our mission becomes a notion of what the specific requirements are for land management purposes, and, in addition, what else can be done. I think we encourage both, but limit our own activities to the one.

Mr. BROWN. Well, I think this is the distinction that we need to draw. Every agency will need to conduct certain information gathering or research activities in performance of its mission.

As the fundamental justification for the Environmental Research Park, there is a growing awareness that we need systematic studies of a wide variety of ecosystems on a long-term continuing basis to give us some basis for judging what has happened to particular environments. Each research activity is important, but the latter one is relatively new. The idea of having an Environmental Research Park or maintaining a system of them for these baseline studies over a long period of time is much newer than the National Park Service, for example, or the Fish and Wildlife Service. I think what the record needs to show is the importance and relationship of these research parks to the research that all of you gentlemen are presently engaged in and possibly how the two concepts can be interrelated and made more mutually productive, if this is possible.

Mr. Monroe, how do you perceive the difference between the research that is going on in land management and what the ERDA people were describing?

Mr. MONROE. I think we are fortunate in BLM that we have the large land mass that we have responsibility for that we are doing a lot of what ERDA is doing, too. We have direct research by several hundred of our own employees. We hire contractors who do it based on our specifications, and we also permit others, Federal agencies, institutions, or individuals to come onto the land to do research type work. I think in many areas we are able to do a lot of the same things ERDA is doing but we just do not call it the same thing. We do not have a NERP, if that was the term, that would be established. We do have these smaller identified outstanding natural areas, primitive areas, Research Natural Areas and those are just designed for that purpose.

But our objective under the law is to provide a balance in this multiple use mix of how the land is to be managed, how it is to be used,

how it is to be protected—and research is a very key part of this. And we have to do it or we will be lost. The baseline is good. We have established that in many areas over a number of years.

Mr. BROWN. In principle, do any of you gentlemen see any reasons why there should not be some sort of an information network which would allow the pooling of your research and some degree of common planning for achieving certain research objectives to which each of several different agencies might contribute? Or is this inherently impossible in our system of government?

Mr. NELSON. No, I do not think so.

Mr. MONROE. Probably not impossible but maybe unworkable, getting awfully monolithic.

Dr. SUDIA. Let me make a clarifying point and then I will try to answer your question.

In the area of land management the purpose of the Park Service is to maintain the parks in their natural condition, which really entails understanding basic ecosystem processes. So, part of our basic mission is to do essentially what the ERDA people are trying to do, namely, understand basic ecosystem processes. When you go away from that, like wildlife management, which may not involve basic ecosystems processes, but wildlife enhancement, you depart from that kind of thing, but the motions really are quite similar and quite compatible.

Mr. BROWN. How does this relate to something like Yellowstone or Yosemite? You want to understand the ecosystems but you still have umpteen million people tramping through that park every year.

Dr. SUDIA. Well, part of the thing that is pretty misunderstood about parks is that very little of their area is used by the public. Two or three percent of Yellowstone, maybe five percent of Yosemite is used by the public and the rest of it is back country. In order to understand some of the larger questions, say, concerning fire or the ecology of the grizzly bear, it is really quite necessary to consider almost the totality of the park plus other adjoining lands as being the necessary ecosystem to study. The inner-agency grizzly bear study considers, for instance that Yellowstone is at the heart of about a 5-million acre tract that has to be looked at in order to understand grizzly bears.

Mr. BROWN. I read occasionally something about Yellowstone and the grizzly situation, but obviously Yellowstone has been altered as a result of its use by human beings. That is what it was intended to be used for. It is a great attraction. But have you made the studies that allow you to say, over a period of years that the park has been under your jurisdiction, what the changes in the ecology are as a result of human intervention?

Dr. SUDIA. We can answer some of those questions. The early alteration of the park affected the grizzly bear primarily allowing the grizzly to use human garbage and food. Since the termination of that we feel that we have restored the grizzly population to its natural ecological condition and renewed one human impact. At the time this was done it was thought that nobody would ever see a grizzly bear again. The fact of the matter is that this is not true. It has not happened.

The other thing that I was trying to say is that even a park as large as Yellowstone—2½ million acres—is not enough to contain, say, the total migration of the elk. The elk migrate out of the park, some to the south and some to the north. So the question of how much is enough in many cases really cannot be answered, but for instance in the elk question, we are attempting to understand the natural ecological condition of the elk and to understand the forces that normally control those populations rather than human intervention. In that instance we have not had a human intervention elk reduction for a number of years. We now feel that we understand to a greater extent what the natural ecological conditions are.

To address your question of the information, I think that our agencies at least are going through something at about the same time. In response to NEPA, in response to the Endangered Species Act of 1973, most agencies now have to pretty well document what they are doing. Agencies may or may not have documented what they did in the past. For example—we have had Yellowstone since 1872—can we say that we really have a record of change out there since 1872? In many cases we do not, but in many cases we do, and in the cases where we do, it is happenstance. It is not due to orderly, planned, 100-year research projects. But I think that particularly if one looks at the various clauses of the National Environmental Policy Act, we are now no longer allowed the luxury of ignoring what it is we do and the consequences of our acts. I can say certainly for the Park Service that comprehensive systems of inventorying, utilizing in many cases modern technology such as remote sensing satellites is in fact occurring and we are beginning to get quantitative information on large parcels of land that we have never had before. In addition to this, it means that the information that we are getting occurs in such vast quantity that it has to be reduced to computer technology for analysis and in many cases even for display.

I think that what is happening now in the land management activities is that there is enough scientific expertise maturing in this area, that with very little effort such as adoption of similar standards by various agencies, a common pool of information of this kind would be readily available and readily accessible, that is to say, utilizing a computer based data information system should be readily accessible from agency to agency.

We meet regularly with the Forest Service and other agencies and discuss our common research problems and in many cases this is the issue that comes up—how we can pool not only the information that we have, but also pool information about what we are going to do so that we do not keep reinventing the wheel or keep doing what somebody else is doing. I think that because of the demands required for comprehensive data analysis, in the not too distant future this kind of information exchange should be readily available.

Mr. BROWN. Well, there will be increasing pressures on you to develop the kind of systems that will allow for the exchange of data. There will also be increasing pressures on you to have available for policy purposes and other purposes a much broader range of information. Unreasonable Congressmen or the unreasonable laws that they

pass are going to require some of these things, just as NEPA, and later acts which mandate enhanced or increased planning for BLM, Forest Service, and all of the agencies are going to require this kind of data. We are going to get to the point where we need to know things like the CO_2 uptake of all the vegetated areas of the United States, or how much sunlight is being reflected or something like that. And it is going to put tremendous demands on you, thus emphasizing the importance of taking a very broad look at your research mission, more comprehensive I think than we have been accustomed to taking in the past.

Gentlemen, I am afraid I am going to have to start answering some of these roll calls that are coming up. Let me say again that I very much appreciate your helping us with the perspective that you have presented this morning. We hope to keep in touch with you about this.

Thank you very much.

[The prepared statements of Mr. Nelson, Mr. Monroe, and Dr. Saudia follow:]

STATEMENT OF MARCUS C. NELSON, CHIEF, DIVISION OF NATIONAL WILDLIFE REFUGES, U. S. FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR, BEFORE THE HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON THE ENVIRONMENT AND THE ATMOSPHERE ON THE ADEQUACY OF FEDERAL LANDS FOR ENVIRONMENTAL RESEARCH, JULY 28, 1977.

I appreciate the opportunity to appear before you today and discuss the role of the U. S. Fish and Wildlife Service in wildlife research on lands administered by the Service.

The overall mission of the U. S. Fish and Wildlife Service is broad in scope and diverse in character. It ranges from the protection and management of continental waterfowl populations to providing assistance to inner city residents in nuisance bird control; from the maintenance of the anadromous fishery to the control of importations of endangered wildlife species. Research is essential to determine the basic requirements of different species, the interactions of wildlife species with each other and with their habitats, the effects of human activities upon wildlife, and the human needs that are fulfilled by wildlife. Our research centers around waterfowl management, other migratory birds, wildlife ecology on public lands, pesticide-wildlife relations, diseases and parasites, animal damage control, life history studies on birds and mammals, endangered species, and foreign wildlife investigations.

The majority of Fish and Wildlife Service land lies within the National Wildlife Refuge System. The system includes over 32 million acres in 384 units in 49 States and 8 Territories. Although research is not the highest priority on refuges, it is an important objective and supplies facts necessary in making management decisions. Service policy encourages and supports wildlife oriented research on units of the system.

Refuge lands, water, and facilities may be used for research by non-Service entities when this research does not conflict with other refuge programs or responsibilities of greater value or priority. Studies designed to help resolve wildlife management problems of individual refuges, or of the refuge system as a whole, are especially encouraged.

All research or study proposals to be conducted on refuges must be approved by the refuge manager to insure that due consideration is given at the resource level to biological, social, and economic aspects of the study, and that potential conflicts with other programs are recognized and resolved. A publication, "Research Opportunities on National Wildlife Refuges," is available to persons interested in using refuge units as research sites. I would be pleased to supply a copy of this publication for submission to the record of this hearing.

During 1976, 392 studies were conducted on 129 refuges. Of these, approximately 68 percent were conducted by non-Service people.

National wildlife refuges are protected by law, and additional legislation to insure long-range protection of sites now available for research is not necessary. In addition, further protection is afforded sites administratively designated as Research Natural Areas or legislatively designated as part of the National Wilderness Preservation System.

In response to growing national recognition of the need to preserve natural environments and ecosystems, the Service is cooperating with other Federal land managing agencies in the identification, classification, and establishment of Federal natural areas.

The National Wildlife Refuge System has 181 Research Natural Areas (RNA's) on 88 National Wildlife Refuges. Research Natural Areas on refuge land may be as small as a few acres or as large as several thousand, depending on the ecosystem they represent. These areas, set aside for scientific and education purposes, total nearly 2 million acres.

In the U. S. Fish and Wildlife Service, a Research Natural Area is an area where natural processes are allowed to predominate. These areas may include typical or unusual faunistic and/or floristic types, associations, or other biotic phenomena, or characteristic or outstanding geologic, pedologic, or aquatic features and processes.

Research Natural Areas provide important baselines against which man-caused changes can be measured. They are useful for evaluating the improvement or impairment resulting from the intervention of man in the otherwise natural environment. The urgency for setting aside and protecting these areas becomes greater as our expanding population increases our demands on the land; as our concern for soil, water, and atmospheric pollution grows; and as far-reaching environmental controls, such as weather modification, become a reality.

In many cases, Research Natural Areas and other refuge lands have been further protected by the designation of a wilderness. These may be protected from encroachment by fences or signs, but normally the unobtrusive character or isolated location of the areas offers adequate protection. Research on these areas must be non-destructive and reasonably consistent with the purpose and character of the surrounding land.

Studies that require manipulation of the environment are normally done elsewhere. Scientists and educators are encouraged by the Fish and Wildlife Service to use these areas. Restrictions are applied only to preserve the natural values of the area and to protect any research projects already underway. A written permit is required, and a summary report must be submitted upon completion of a research project.

Biosphere Reserves have been established on the San Andreas National Wildlife Refuge in New Mexico and the Aleutian Islands National Wildlife Refuge in Alaska. They were designated by the International Coordinating Council of UNESCO. These areas conserve specific biotic communities and provide opportunities for baseline ecological and environmental research.

In addition to the National Wildlife Refuge System, the Service maintains lands in the National Fish Hatchery System and at wildlife research centers. Fish hatchery lands are not generally useful as environmental research reserves, since the land and water is developed primarily to provide controlled environments for fish propagation and fishery research. Lands associated with the research centers, although well protected and necessary to wildlife research, are not classified as environmental research reserves, and would not benefit by having their flexibility to accommodate a variety of controlled research projects impaired. It may be of interest, however, that at the Patuxent Wildlife Research Center in Laurel, Maryland, 2,000 acres have been maintained in a natural state for many years prior to acquisition by the Service. Since 1944 long term ecological research has been conducted on this tract which today is unique in this part of the country.

While most of the research is in-house, the area is available for approved studies by other Federal agencies, universities and independent researchers.

In conclusion, Mr. Chairman, I believe that adequate authority exists for the U. S. Fish and Wildlife Service to preserve and protect lands and waters under its jurisdiction as natural areas and to make such areas available for useful and desirable research.

This concludes my prepared statement. I would be pleased to answer any questions you might have. Thank you.

POLICY UPDATE NO. 3

DATE: November 1, 1973

POLICY ON RESEARCH ON LANDS AND WATERS OF THE NATIONAL WILDLIFE REFUGE SYSTEM

Policy

It is the policy of the Bureau of Sport Fisheries and Wildlife to encourage and support wildlife-oriented research on units of the National Wildlife Refuge System. Bureau funds, labor and/or material, when available, may be committed where there is a high priority need for significant management-oriented information. Refuge lands, water and/or facilities may be made available for research by non-Bureau entities when not in conflict with other refuge system outputs or responsibilities of greater value or priority and a mutual benefit may be obtained.

Objectives

The primary objective of the Bureau is "to promote harmony between man and his environment." As the basic biological agency of the Federal Government, the Bureau is responsible for contributing to this "harmony." Especially encouraged on national wildlife refuges are management-oriented research projects or studies which will lead toward solving management problems on individual refuges or the System as a whole. Some of the System's most critical research needs involve promoting the understanding and enjoyment of refuge lands through public use and eliminating or minimizing public abuse.

All research must have clearly defined objectives and justification. Primary consideration is given to research which is needed and required in the Refuge System. Eliminated from consideration are hobby, cursory, "masters degree mill," and related projects that have little or no significance in furtherance of refuge objectives.

C. Delegation of Authority

This policy update further expands 4 AM 4.9, Delegation by the Director - Wildlife Matters, to authorize refuge managers to approve research, refuge management studies or investigations on units of the National Wildlife Refuge System (NWRS) by Bureau or non-Bureau personnel when Bureau expenditures are not required and no significant conflict exists with other Bureau objectives. Regional Directors are authorized to approve research requiring expenditure of Bureau funds.

D. Guidelines

All research or study proposals that are to be conducted on NWRS units must be approved by the refuge manager. This will insure that at the resource level due consideration is given the biological, social, and economic aspects, and that potential conflicts with other Bureau programs are recognized and resolved.

Proposals will normally be in accordance with the following format:

1. Title of study (state concisely).
2. Objectives: (number each objective, defining it clearly and concisely, limiting each statement to a goal of possible accomplishment).

3. Justification: (outline extent of knowledge and background; describe briefly how the study will contribute to better management of the area or its importance to other fields).

4. Procedure:
   a. Literature review.
   b. Data collecting (cover techniques and location of activities, describe any markers, structures, or other material to be placed on NWRS unit and affirm that such material will be removed by the investigator; describe in detail any capture, markings, or tagging techniques. Be sure to cover who is to do what, when, where, and how. If animals (including birds, reptiles, etc.) or their eggs are to be collected or sacrificed, the plan should note the official status of the species involved (rare, endangered, etc.), indicating what impact on the species is expected to result from the proposed research).
   c. Data analysis and interpretation.
5. Cooperators (list other participating institutions, agencies, organizations, or individuals, if any).
6. Responsibility: (set forth work and supervision responsibilities. Indicate role to be played by the NWRS unit, especially anything in addition to providing the study area).
7. Cost: (costs, if any, to the Bureau of Sport Fisheries and Wildlife should be broken down by fiscal year--July 1 to June 30--and include man-years, equipment, supplies, etc., to accomplish the study).

8. Schedule: (estimate starting and completion dates. If a portion of any given study is to be accomplished separately, the recommended starting and completion dates of each phase should be shown).

9. Reports: (establish due dates for progress and final reports and indicate the number of copies to be furnished to the refuge manager. When Bureau funds are involved, copies of reports will be required by the offices outlined in E. Procedures, paragraph no. 1.)

10. Publications: (state plans, if any)

11. Submitted by: (if student study, major responsible professor should also sign).

Cooperator(s) endorsement(s)_____ Date:_____

Approved:_____ Date:_____

12. (a) Recommended by:_____
Refuge Manager

(b) Recommended by:_____
Regional Supervisor

(c) Reviewed by:_____
Research, Wildlife or Fisheries (when Bureau funding involved)

(d) Approved by:_____
Regional Director

E. Procedures

When Bureau funds are involved, the refuge manager will submit the proposal (four copies) to his immediate supervisor with a brief, concise supporting statement. The supervisor will weigh the proposal according to competing priorities. He will then forward three copies to the Regional Director with his recommendations and one copy to the Central Office Division Chief of Wildlife Research or Fishery Research (as appropriate) for review and comment. It is anticipated Regional Directors will have the benefit of research review prior to his consideration. The Regional Director will approve or disapprove the proposal, providing an information copy of approved proposals to the Division of Wildlife Refuges in the Central Office, retaining one copy for Regional files, returning an approved copy to the refuge.

When the approved project is completed, the finalized results will be forwarded through the same chain of command. Reviewers at all levels will evaluate the results and offer comments or recommendations to the next level. It will be the ultimate responsibility of the Regional Director to place the evaluation in proper perspective and make arrangements for dissemination of the data to the persons, units, or organizations which stand to benefit most by the information gained.

This policy update does not supersede or alter any operating procedure currently operative in Divisions other than Wildlife Refuges. It is intended to insure that research conducted on Bureau lands is of high priority, has benefit of review of the appropriate Research Division, and adequately considers the objectives of the NWR System.

APPENDIX 3

RESEARCH NATURAL AREAS *

In response to growing national recognition of the need to preserve natural environments and ecosystems and to help achieve one of the goals of the International Biological Program, the Bureau of Sport Fisheries and Wildlife is cooperating with other land administering agencies of the Government in the identification, classification, and establishment of Federal Natural Areas.

The Interdepartmental Natural Areas Committee has developed objectives, definitions, a classification system, and minimum criteria for selection, management, and protection of Research Natural Areas. These follow, as well as the form to be used in submission to the Director of proposed Research Natural Areas.

OBJECTIVES

1. To assist in the preservation of examples of all significant natural ecosystems for comparison with those influenced by man.

2. To provide educational and research areas for scientists to study successional trends and other aspects of the natural environment.

3. To serve as a gene pool and help to preserve native and endangered species or other varieties of plants and animals.

DEFINITION

An area where natural processes are allowed to predominate and which is preserved for the primary purpose of research and education. Such may include:

1) Typical or unusual faunistic and/or floristic types, associations, or other biotic phenomena.

2) Characteristic or outstanding geologic or aquatic features and processes.

* Adapted from Mr. Tunison's memorandum of July 13, 1966, with attachments

APPENDIX 3

SELECTION CRITERIA

While a project leader will normally be responsible for proposing the establishment of a Natural Area, any employee may suggest an appropriate area for consideration.

Research Natural Areas are established by the Director. Information requested on the submission form is all that is presently needed to propose a Research Natural Area for establishment by the Director. However, personnel at each region or project on which a Research Natural Area is located should be prepared to maintain records and files containing information in considerably greater detail than called for on the attached form. Instructions and guidelines for these regional and field records and files will be forthcoming.

Approved Research Natural Areas, through 1967, are shown in Research Natural Areas, 1968, compiled by the Federal Committee on Research Natural Areas. Each field station received a copy of this publication and should use it as a reference.

The types listed on pages 89-104 of Research Natural Areas, 1968 attempt to be all-inclusive, but it is not intended that this list be considered closed. If there are additional types that should be represented, please name, briefly describe, and appropriately number them. We are particularly concerned that types for desert, semi-desert and wetlands areas are not complete.

Natural Areas should be of such size and extent that they afford an adequate degree of protection and preservation for the type or feature being preserved. Although no arbitrary acreage figure can be laid down for the size of a Natural Area, it is generally difficult to maintain essentially unmodified conditions in areas smaller than 25 acres unless they are buffered by scenic or other areas that are maintained in a relatively unmodified condition.

APPENDIX 3

Two types of Research Natural Areas are recognized under Management Criteria. In one, succession is allowed to advance towards climax without interference. These areas conform to the commonly accepted concept of Research Natural Areas. In the other, appropriate management is applied to hold succession at a desired natural stage that would otherwise advance towards climax. Such areas would normally be established where it is apparent that natural dis-climaxes are disappearing because of man's activities. An example is the grasslands on the west slope of the Sierra Nevada which have largely been lost because of fire control and changes in land use. In the designation of each Research Natural Area and in documents and instructions relating to its management and protection, it should be made very clear, of course, for which of these two purposes it is established.

The third paragraph under protection criteria indicates that public use on Research Natural Areas will be discouraged. This is somewhat at variance with the penultimate paragraph of Section 1316 of the Wildlife Refuges Manual, which permits nature trails in Natural Areas. This supersedes the Refuge Manual. It may be desirable to change boundaries to exclude nature trails. In the delineation of Research Natural Areas, take into consideration that a significant segment of the public enjoys using natural environments for purposes other than prescribed here. If the size of a natural ecological type permits, it may be advisable to set part of it aside for use by the general public as a Public Use Natural Area through development of nature trails, identification signs, maps, and other devices, as well as having an adequate portion of it separately designated as a Research Natural Area. Only the latter, of course, would be described on the Research Natural Area form, and no publicity would be given the Research Natural Area.

It is not possible to provide hard and fast guidelines for the condition of a Natural Area at the time of its selection. However, it is expected that a site suggested for natural area status would, at the time it is proposed, conform to a reasonably close degree with the definition of a natural area as presented above. In addition, at the time it is established a Natural Area should be as free of man-caused disturbance as possible.

APPENDIX 3

The present development of a Natural Areas System comes at a time when candidate Wilderness Areas are being delineated and studied for possible inclusion in the Wilderness System. Since some Bureau lands may qualify for both Wilderness and Natural Areas, the following points may assist you in deciding which category areas best qualify:

1. All qualified islands and areas of 5,000 acres and more must be studied as candidate for inclusion in the Wilderness System. No requirements have as yet been imposed for study of areas for possible establishment as Natural Areas.

2. Wilderness Areas have protection of congressional action. Natural Areas are established by the Director.

3. One or more Natural Areas may be established in a Wilderness Area. The reverse is generally not contemplated. However, an entire Wilderness Area on a National Wildlife Refuge could be managed as a natural area, under wilderness regulations, for the preservation of ecosystems and wildlife species (such as the grizzly bear) having large space requirements.

4. Public recreation, under strict ground rules, is generally permissible on Wilderness Areas. General public use is discouraged on Research Natural Areas.

5. Wilderness Areas are unmanaged from the standpoint of habitat manipulation. Natural Areas may be managed, if necessary, to maintain the type or stage of succession for which it was established. (see above)

MANAGEMENT CRITERIA

A Natural Area must be protected against activities which directly or indirectly modify natural ecological processes or alter the type or feature which is being preserved. Manipulative practices such as grazing, prescribed burning, timber cutting and the use of chemicals for plant, insect and disease control are not permitted unless such are necessary to maintain the type or process for which the Natural Area was established or unless necessary to prevent the spread of

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APPENDIX 3

insects or disease to adjacent areas. Natural Areas should be withdrawn from mineral and oil entry when possible within existing legislation.

Generally speaking, no permanent physical improvements such as roads, fences, or buildings should be permitted within a Natural Area. Temporary facilities needed for research, such as instrument or personnel shelters, may be installed with the approval of the office which granted permission for the research activity. Except as essential for control of wildfire no buildings or roads should be constructed at the boundaries of a Natural Area.

PROTECTION CRITERIA

Studies within a Natural Area will be restricted to approved and responsible research projects which do not materially alter the ecosystem or the natural values for which the area was selected. Visitation by ecologists, botanists, zoologists, or other competent scientists will be permitted. Educational or interpretive visits will be permitted on a group basis on selected Natural Areas when suitable advance arrangements have been made to assure proper supervision.

Natural area boundaries need not be fenced unless necessary for protection against livestock or excessive unauthorized human use. Signs which would tend to attract sightseers, recreationists, and casual visitors should be avoided. However, if roads or trails pass along the boundary or through the Natural Area, limited posting may be needed to protect the area.

It is not contemplated that Natural Areas will be for general public use. However, it is recognized that some public entry is unavoidable. Project leaders should attempt to discourage public entry in such a manner as to cause as little attention as possible to be directed to the area.

Normally, wildfires within a Natural Area should be extinguished as quickly as possible, but no cleanup, fire hazard reduction, reforestation, or revegetation should be undertaken. Insect or disease-killed trees and plants are a part of the Natural Area and should not be felled or removed.

28 APRIL 1977
(Neely)

RESEARCH
NATURAL AREAS
ON
U.S. FISH AND WILDLIFE SERVICE LANDS

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 1			
Anaho Island	Anaho Island	Z-16 Birds (nesting pelicans, cormorants)	247
Columbia	Drumheller Sagebrush steppe	K-55 Sagebrush Steppe	465
Desert	Basin	SAF-237 Interior Ponderosa Pine	650
Desert	Hayford Peak	SAF-209 Bristlecone Pine	2,000
Desert	Deadhorse	K-53 Grama-Galleta Steppe	3,000
Desert	Pinyon-Juniper	SAF-239 Pinyon Juniper	500
Desert	Papoose Lake	K-40 Saltbush	23,680
Hart Mountain	Poker Jim Ridge	SAF-238 Juniper Sagebrush	640
Hawaiian Islands	French Frigate Shoals	Z-16 Birds (seabird colonies)	107,772
Hawaiian Islands	Gardner Pinnacles	Z-16 Birds (seabird colonies)	6
Hawaiian Islands	Laysan Island	Z-16 Birds (Laysan teal, Laysan finch, seabird colonies)	1,010
Hawaiian Islands	Lisianski Island	Z-16 Birds (seabird colonies)	383

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 1 (Con't)			
Hawaiian Islands	Necker Island	Z-16 Birds (seabird colonies)	45
Hawaiian Islands	Niohoa Island	Z-16 Birds (Nioha millerbird, Nihoa finch, seabird colonies)	170
Hawaiian Islands	Pearl & Hermes Reef	Z-16 Birds (seabird colonies)	95,582
Kern	San Joaquin Desert	Z-15 Blunt-nosed Leopard-Lizard; Z-17 San Joaquin Kit Fox	2,260
Little Pend Oreille	Baird Basin	SAF-214 Ponderosa Pine, Larch-douglas-Fir	160
Little Pend Oreille	Varline Grove	SAF-212 Larch-douglas Fir	160
Malheur	Stinking Lake	A-26 Saline Lake	1,555
Malheur	Harney Lake	A-26 Saline Lake	30,000
Ridgefield	Blackwater Islands	SAF-233 Oregon White Oak	129
Ruby Lake	Ruby Valley Marsh	A-19 Large shallow lake	10,000
Turnbull	Pine Creek	SAF-237 Interior Ponderosa Pine	160
Turnbull	Turnbull Pines	SAF-237 Interior Ponderosa Pine	197
Willapa	Diamond Point	SAF-225 Sitka Spruce-Western Hemlock	80
William L. Finley	Pigeon Butte	SAF-233 Oregon White Oak	38
William L. Finley	Maple Knoll	OVT (Bigleaf Maple)	100
William L. Finley	Willamette Flood Plain	OVT Prairie and Oregon Ash	239

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 2			
Anahuac	Lone Tree Bayou	A-7 Tidal Salt Marshes	200
Bitter Lake	Bitter Lake	A-26 Saline Lakes	300
Bitter Lake	Lake St. Francis	A-30 Sinkhole Lakes	700
Bitter Lake	Ink Pot	A-30 Sinkhole Lakes	2
Bosque del Apache	Chupadera	K-58 Grama Tobosa Scrubsteppe	5,300
Bosque del Apache	San Pasqual	K-58 Grama-Tobosa Scrubsteppe	3,200
Bosque del Apache	Rio Grande Marsh	K-49 Tule Marshes	97
Bosque del Apache	Apache Camp	SAF-235 Cottonwood-Willow	220
Bosque del Apache	Jornada del Muerto	OVT (Giant Dropseed)	10,000
Brazoria	Christmas Point	K-78 Southern Cordgrass Prairie	175
Buffalo Lake	High Plains	K-65 Grama-Buffalo Grass	320
Cabeza Prieta	Antelope Flat	K-41 Cresote Bush	57
Cabeza Prieta	Sierra Pinta	K-43 Palo Verde-Cactus Shrub	5,120
Cabeza Prieta	Pinacate	K-43 Palo Verde-Cactus Shrub	5,120
Cabeza Prieta	Kearney Sumac	OVT (Kearney Sumac)	23,040
Hagerman	Dickey-Hagerman	SAF -40 Post Oak-Black Oak	40
Hagerman	Brooks-Hagerman	SAF-40 Post Oak-Black Oak	50
Havasu	Bill Williams	SAF-235 Cottonwood-Willow	440

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 2 (Con't)			
Kofa	Fishtail Canyon	OVT (Palms)	200
Kofa	Palm Canyon	OVT (Palms)	225
Laguna Atascosa	South Texas Cordgrass Prairie	K-78 Southern Cordgrass Prairie	50
Laguna Atascosa	Granjeno	K-60 Mesquite Savanna	125
Las Vegas	Vegosa	K-65 Grama-Buffalo Grass	537
Las Vegas	Gallinas	SAF-239 Pinyon-Juniper	385
Maxwell	Maxwell	K-65 Grama-Buffalo Grass	80
Salt Plains	Dog Ranch	SAF-235 Cottonwood-Willow	100
Salt Plains	Sand Creek	K-74 Bluestem Prairie	250
Salt Plains	Powell Creek	A-29 Swamps and Marshy Areas	100
Santa Ana	Texas Ebony	OVT (Texas Ebony)	68
Wichita Mountains	North Mountain	K-69 Bluestem-Grama Prairie	3,900
REGION 3			
Crab Orchard	Post Oak Flats	SAF-40 Post Oak-Black Oak	22
Crab Orchard	Crab Orchard Creek Bottoms	SAF-65 Pin Oak-Sweet Gum	105
Crab Orchard	Devil's Kitchen Dam	SAF-59 Yellow Popular-White Oak-Northern Red Oak	130
Crab Orchard	Big Grassy Creek	SAF-52 White Oak-Red Oak	42

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 3 (Con't)			
Crab Orchard	Area 10	SAF-95 Black Willow	40
Crab Orchard	Crab Orchard Cemetery	SAF-46 Eastern Red Cedar	70
Crab Orchard	Little Grassy Creek	SAF-61 River Birch-Sycamore	20
Crab Orchard	The Oxbow	SAF-95 Black Willow	160
Crab Orchard	Devil's Kitchen Lake	G-17 Unglaciated Sandstone Bluffs	136
Crab Orchard	Devil's Kitchen Well	SAF-52 White Oak, Red Oak, Hickory, Walnut	42
Crab Orchard	Pigeon Creek	SAF-52 White Oak-Red Oak-Hickory	40
Crab Orchard	Post Oak Flats Addition	SAF-40 Post Oak-Black Oak	50
Crab Orchard	Wolf Creek Bay	SAF-63 Cottonwood	40
Crab Orchard	Wolf Creek (East Tributaries)	SAF-52 White Oak-Red Oak-Hickory	330
Chautauqua	Cameron	SAF-62 Silver Maple-American Elm	177
Chautauqua	Rountree	OVT - Black Oak-Mockernut Hickory	26
Necedah	Necedah Jack Pine	SAF-1 Jack Pine	80
Necedah	Sandstone Natural Area	K-81 Oak Savanna	240
Ottawa	West Sister Island	OVT Hackberry	82

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 3 (Con't)			
Rice Lake	Rice Lake	SAF-38 Tamarack	100
Seney	Northern Hardwood	SAF-25 Sugar Maple-Beech-Yellow Birch	500
Seney	Red Pine	SAF-15 Red Pine	640
Seney	Hemlock	SAF-23 Hemlock	50
Seney	Strangmoor Bog	G-32 Unusual Geologic Phenomena	640
Tamarac	Height of Land	SAF-26 Sugar Maple Basswood	73
Tamarac	Sugarbush	SAF-26 Sugar Maple Basswood	135
Upper Mississippi	Nelson-Trevino	SAF-62 Silver Maple-American Elm	3,740
Upper Mississippi	Reno Bottoms	SAF-62 Silver Maple-American Elm	1,980
Upper Mississippi	Thomson-Fulton Sand Prairie	K-74 Bluestem Prairie	300
Upper Mississippi	Twelve Mile Island	SAF-62 Silver Maple-American Elm	900
REGION 4			
Big Lake	Big Lake Bald Cypress	SAF-101 Bald Cypress	500
Blackbeard	Blackbeard Island	SAF-85 Slash Pine-Hardwood	450
Cape Romain	Bulls Island	SAF-74 Sand Live Oak-Cabbage Palmetto	500

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 4 (Con't)			
Cape Romain	Bulls Island	SAF-82 Loblolly Pine-Hardwood	500.
Cape Romain	Bulls Island Red Cedar	SAF-73 Southern Red Cedar	80.
Carolina Sandhills	Carolina Sandhills	SAF-71 Longleaf Pine - Scrub Oak	554.
Choctaw	Choctaw Water Tupelo	SAF-103 Water Tupelo	35.
Holla Bend	Hog Thief	SAF-63 Cottonwood	100.
J. N. "Ding" Darling	Norberg	A-8 Red and Black Mangrove	150.
Lake Woodruff	Honey Creek	K-78 Southern Cordgrass Prairie	1,140.
Loxahatchee	Loxahatchee Slough	K-92 Everglades	2,560.
Mattamuskeet	Salyer's Ridge	SAF-81 Loblolly Pine	75.
Noxubee	Morgan Hill	SAF-49 Eastern, Red Cedar-Pine-Hardwood	67.
Noxubee	Old Robinson Road	SAF-101 Bald Cypress	46.
Okefenokee	Black Jack Island	A-29 Swamp and Marshy Area	15,027.
Okefenokee	Cowhouse Island	SAF-89 Live Oak	10.
Okefenokee	Floyd's Island	SAF-72 Southern Scrub Oak	160.

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 4 (Con't)			
Okefenokee	Sweet Bay	SAF-104 Sweetbay-Swamp Tupelo-Red Maple	2,560
Okefenokee	Pine Island	SAF-98 Pondpine	90.
Okefenokee	Pond Cypress	SAF-100 Pond Cypress	14,989.
Okefenokee	Territory Prairie	A-29 Swamps & Marshy Area	1,450.
Piedmont	Five Points	SAF-80 Loblolly Pine - Shortleaf Pine	118.
Sabine	Blue Islands	K-78 Southern Cordgrass Prairie	112.
St. Marks	Otter Lake	SAF-71 Longleaf Pine - Scrub Oak	93.
St. Marks	St. Marks Tidal Marsh	A-7 Tidal Salt Marsh	1,066.
Tennessee	Britton Ford	SAF-48 Eastern Red Cedar-Hardwood	750.
Wheeler	Bluff City	SAF-46 Eastern Red Cedar	13.
White River	White River Sweetgum	SAF-92 Sweetgum-Nuttall Oak-Willow Oak	973.
Yazoo	Swan Lake Black Willow	SAF-95 Black Willow	400

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 5			
Bombay Hook	Marshall Island	A-7 Tidal Salt Marshes	120
Brigantine	Little Beach Island	A-2 Exposed Coastline with Unconsolidated Sediment	1,250
Brigantine	Egg Island	Z-16 Birds laughing gulls and clapper rails	600
Brigantine	Lilly Lake Bog	OVT-Losels Twayblade Orchid	1
Chincoteague	Chincoteague Natural Area	SAF-80 Loblolly Pine-Short-Leaf Pine	150
Eastern Neck	Hail Point	A-7 Tidal Salt Marsh	149.
Erie	Lake Creek	A-29 Swamps & Marshy Areas	700
Erie	Muddy Creek	A-29 Swamps & Marshy Areas	1,072
Erie	Jacob Guy	SAF-25 Sugar Maple-Beech-Yellow Birch	160
Great Swamp	M. Hartley Dodge	SAF-52 White Oak-Red Oak-Hickory	746.
Iroquois	Milford Posson	SAF-25 Sugar Maple-Beech Yellow Birch	15.
Missisquoi	Shad Island	SAF-39 Black Ash-American Elm-Red Maple	114.

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 5 (Con't)			
Montezuma	Beach-Maple Knoll	SAF-60 Beech-Sugar Maple	8
Montezuma	Swamp Woods	SAF-39 Black Ash-American Elm-Red Maple	100
Moosehorn	Edmunds Unit	SAF-33 Red Spruce - Balsam Fir	160
Moosehorn	Hobart	SAF-37 Northern White Cedar	10
Moosehorn	Camp Two	SAF-5 Balsam Fir	40
Moosehorn	Moosehorn Meadows	Z-16 Birds (managed woodcock habitat)	50
Moosehorn	Sunken Bog	A-25 Sphagnum-Bog Lakes	10
Moosehorn	Bertrand E. Smith	SAF-21 White Pine	160
Parker River	Ludlow Griscom Dune	OVT Bayberry-Beach Plum American Beachgrass	150
Patuxent Wildlife Research Center	Patuxent Natural Area	SAF-65 Pin Oak-Sweet Gum	710
REGION 6			
Bear River	Greasewood Knolls	K-40 Saltbrush-Greasewood	680
Benton Lake	Mullan Trail	K-66 Wheatgrass-Needlegrass	392
Charles M. Russell	Grand Island	SAF-235 Cottonwood-Willow	160
Charles M. Russell	Prairie Dog Island	Z-17 Black-tailed prairie Dog	15
Charles M. Russell	Dillon Island	SAF-235 Cottonwood-Willow	80

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 6 (Con't)			
Charles M. Russell	Two Calf Island	SAF-235 Cottonwood-Willow	30.
Crescent Lake	Hackberry Lake	K-75 Nebraska Sandhills Prairie	172.
Crescent Lake	Goose Lake	K-75 Nebraska Sandhills Prairie	904.
DeSoto	DeSoto	SAF-63 Cottonwood	358.
Fort Niobrara	Fort Niobrara	SAF-237 Interior Ponderosa Pine	200.
Hutton Lake	Laramie Plains	K-66 Wheatgrass-Needlegrass	27.
Kirwin	Solomon River Grasslands	K-69 Bluestem-Grama Prairie	120.
Medicine Lake	Big Island	Z-16 White Pelican	251.
Medicine Lake	Bruce's Island	K-68 Wheatgrass-Grama	367.
Medicine Lake	Homestead	K-64 Grama-Needlegrass-Wheat Grass	39.
Medicine Lake	Tepee Hills	G-29 Human	38.
Mingo	Cypress-Tupelo	SAF-102 Bald Cypress-Water Tupelo	80.
Mingo	Elm, Ash, Maple	SAF-39 Black Ash-American Elm-Red Maple	80.
Mingo	Pin Oak	SAF-65 Pin Oak-Sweet Gum	180.

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
REGION 6 (Con't)			
Mingo	Cherrybark	SAF-91 Cherrybark Oak-Swamp Chestnut Oak	60
Mingo	Oak Hickory	SAF-52 White Oak-Red Oak Hickory	140
Mingo	Overcup Oak	SAF-96 Overcup Oak-Water Hickory	45.
Mingo	Willow Oak	SAF-92 Willow Oak-Sweet Gum-Nuttall Oak	40
Monte Vista	Spring Creek	K-40 Greasewood-Saltbush	14
Quivira	Santana	K-74 Bluestem Prairie	362
Red Rock Lakes	Sheep Mountain	SAF-210 Interior Douglas Fir	85
Squaw Creek	Bluejoint-Slough Grass Prairie	K-73 Northern Cordgrass Prairie	250
Squaw Creek	Loess Hills	G-8 Eolian Land Form	100
Swan Lake	Yellow Creek	SAF-62 Silver Maple-American Elm	1,000
Valentine	Valentine Natural Area No. 1	K-75 Nebraska Sandhills Prairie	530
Valentine	Valentine Natural Area No. 2	K-75 Nebraska Sandhills Prairie	459
Waubay	Hillebrand Lake	SAF-236 Bur Oak	75
ALASKA			
Kenai	Skilak Lake	SAF-201 White Spruce	20

REFUGE OR RANGE	NATURAL AREA	PRIMARY TYPE	ACRES
ALASKA (Con't)			
Kenai	Bedlam Lake	SAF-202 White Spruce-Birch	10
Kenai	Andrew Simon	SAF-202 White Spruce-Birch	830,000
Kenai	Bottinentnin	SAF-16 Aspen	20
Kenai	Nikolai Bay	SAF-12 Black Spruce	20
Kodiak	Mount Glottof	Z-17 Kodiak Brown Bear	88,000
Arctic	Shublik	OVT Arctic Tundra	34,540
Arctic	Firth River - Mancha Creek	OVT Arctic Tundra	520,000
Aleutian Islands	Agattu Island	Z-16 Birds	55,535
Aleutian Islands	Buldir Island	Z-16 Birds	5,000
			1,943,793

181 RNA's
88 Refuges

JUL 2 8 1977

STATEMENT OF JAMES W. MONROE, ASSISTANT DIRECTOR, LEGISLATION AND PLANS, BUREAU OF LAND MANAGEMENT, DEPARTMENT OF THE INTERIOR, BEFORE THE SUBCOMMITTEE ON THE ENVIRONMENT AND THE ATMOSPHERE, COMMITTEE ON SCIENCE AND TECHNOLOGY, UNITED STATES HOUSE OF REPRESENTATIVES ON ENVIRONMENTAL RESEARCH RESERVES.

Mr. Chairman and members of the Subcommittee, I am pleased to have the opportunity to appear before you this morning to discuss Bureau of Land Management programs relating to environmental research reserves.

The Bureau of Land Management has responsibility for management of about 470 million acres of public lands, the vast majority of which are located in the eleven western States and Alaska. For some years, the Bureau has operated under the principles of multiple use and sustained yield and manages these lands for a variety of values and uses, including: domestic livestock grazing, mineral development, watershed values, timber, recreation, and scenic value protection. In carrying out our responsibilities, we utilize a land use planning system which inventories the lands and their resources and considers all potential uses of the land. The Federal Land Policy and Management Act of 1976, approved this past October, specifically requires that the public lands be managed under the principles of multiple use and sustained yield and that such management be in accordance with land use plans. This Act is often referred to as the "BLM Organic Act." It contains a number of other provisions relevant to the Subcommittee's inquiry this morning regarding environmental research reserves. Those provisions will be addressed later in my prepared remarks.

With responsibility for such a vast acreage and such a variety of resource programs, many of which are development-oriented, we have long recognized the need for environmental and scientific research efforts in order to determine the impacts of Bureau programs on the productivity and other characteristics of the lands. For example, many years before enactment of the National Environmental Policy Act, the Bureau fenced areas, referred to as "exclosures", to ascertain the effect of excluding certain activities from a certain tract. While these areas were small in size and may not have been scientifically established and monitored, this practice furnished valuable data when interpreted with data from otherwise roughly comparable areas where there had been no such exclusion of uses.

The Bureau has also attempted to preserve areas worthy of scientific research and study as well as outstanding scenic values within the framework of the limited regulatory and enforcement authority which existed until enactment of the Federal Land Policy and Management Act of 1976. In this regard, a total of about 19 research natural areas and 23 outstanding natural areas have been designated. Research natural areas are established and maintained for the primary purpose of research and study of the environment, successional trends and other natural phenomena of scientific interest. They may contain lands having typical or unusual types of fauna and flora, associations or other biotic phenomena. There may also be outstanding geologic or aquatic features or processes identified and studied. Outstanding natural areas are established to preserve

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scenic values and areas of natural wonder. The primary management objective is preservation of these features in their natural condition.

Examples of research natural areas are the Big Sage Natural Area consisting of 160 acres in Arizona and the McElmo Reptile Natural Area consisting of about 445 acres in Colorado.

One of our best-known natural areas is the Snake River Birds of Prey Natural Area in Idaho. This area, containing 26,000 acres of Federal lands, was designated in 1971 to protect eagles, hawks, falcons, owls, ospreys and vultures. It attracts more nesting raptors than any other known location of similar size in North America and provides myriad opportunities for study and observation.

Recently, the endangered peregrine falcon was reintroduced into the area by substituting peregrine chicks for prairie falcon chicks in active nests. Adjacent Federal lands, while not included in the formally designated Birds of Prey Natural Area, are managed as a study area in conjunction with the natural area. We are presently reviewing this situation to determine whether additional lands are needed for the area and what, if any, additional protection is needed for the resources in the area.

Other examples of outstanding natural areas are Square Butte, Montana, consisting of 1,900 acres to protect unusual geologic formations and the Escalante Canyon, Utah, consisting of about 129,000 acres.

Use of the Bureau's planning system necessitates continuing consideration of the impact of one resource use on other potential resource uses; however, implementation of the National Environmental Policy Act requires an even greater focus on environmental research efforts. In response to NEPA, about 11,400 Environmental Assessment Records were commenced this past fiscal year as were about 200 full Environmental Impact Statements. It is obvious that if we are to perfect our processes and to fully achieve the objectives of NEPA, both with respect to ascertaining the impacts of a proposed action and designing and implementing mitigating measures, we must provide follow-up monitoring to determine the accuracy of our predictions and effectiveness of the mitigating measures. Existence of some exemplary samples of unaltered systems upon which to measure change in impacted areas would be most beneficial to that effort.

In addition to the need for such areas in connection with our NEPA responsibilities, adequate protection of existing areas with environmental and scientific values as well as designation of new areas is authorized and required by the Federal Land Policy and Management Act of 1976, or "FLPMA."

Many of the relevant provisions of FLPMA relate to "areas of critical environmental concern." These are defined as areas within public lands "where special management attention is required . . . to protect and prevent

irreparable damage to important historic, cultural or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards".

Section 102(a)(8) of FLPMA expresses a policy that the public lands be managed in a manner that will protect scientific,ecological, environmental and certain other values.

Section 102(a)(11) expresses a policy that regulations and plans for protection of public land areas of critical environmental concern be promptly developed.

The definition of multiple use in the Act specifically recognizes management for scientific values.

Section 201 of FLPMA requires that in preparing an inventory of all public lands and their resource values, priority be given to areas of critical environmental concern. Section 202(c)(3) provides that in the development and revision of land use plans, priority must be given to the designation and protection of areas of critical environmental concern. We anticipate that many areas suitable for environmental and other scientific research will be identified and designated pursuant to these provisions. The BLM is presently in the process of developing field criteria and guidelines for inventory of such areas. These guidelines should be available for use in the next few months.

The Federal Land Policy and Management Act also contains authority to manage and protect these areas once they are established, including comprehensive regulatory and enforcement authority, withdrawal authority, and acquisition, exchange, and permitting authorities.

Other provisions of some interest with respect to environmental research are:

- provisions requiring a wilderness review and submission of recommendations for additions to the National Wilderness Preservation System. With respect to our present research and outstanding natural areas such review and recommendations will be completed on a priority basis.

- provisions for use of public lands by other Federal agencies where the proposed use is similar to or closely related to programs of the Secretary for the lands involved.
- authority to conduct studies and experiments alone or in cooperation with others involving management, protection or development of the public lands
- authority to enter contracts and cooperative agreements involving management protection and development of public lands.

While NEPA applies to all Federal programs, the activities and authorities in the Federal Land Policy and Management Act that I have discussed thus far are not applicable to the Outer Continental Shelf. With respect to the OCS, no areas have been set aside or designated for environmental research. Since leasing is entirely discretionary and adequate regulatory authority is provided under the present law and the House and Senate versions of the OCS Lands Act Amendments, we do not feel that any additional authority is needed to protect areas for environmental research on the OCS. Further, it is our understanding that such research reserves could be established

under the Marine Sanctuaries Act which is administered by the Department of Commerce. We look forward to working with the Office of Coastal Zone Management in that Department with respect to any such designations on the OCS.

In addition to our own Bureau programs, we are participating in a Departmental study somewhat related to environmental research areas. Currently, there is within the Department--stemming from the President's Environmental Message--a task force developing a National Heritage Trust proposal. This task force includes private citizens, conservation organizations, and government agencies. The objective is to define and develop mechanisms to preserve and protect examples of America's cultural and natural heritage. Management objectives would include provision for consistent and compatible scientific, educational and other public use as well as insuring that significant information on America's cultural and natural heritage is not lost.

In summary, we have already taken some steps toward establishing a system of environmental research areas by designating our present natural areas. Pursuant to NEPA, the Federal Land Policy and Management Act and the President's Environmental Message, we plan to identify and designate other areas suitable for environmental research. Our current authority is sufficient to accomplish these objectives, as well as to protect the areas established.

STATEMENT BY THE DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE, BEFORE THE SUBCOMMITTEE ON THE ENVIRONMENT AND ATMOSPHERE, HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY ON ENVIRONMENTAL RESEARCH NETWORKS.

July 28, 1977

MR. CHAIRMAN, IT IS A PRIVILEGE FOR ME TO APPEAR BEFORE YOU TO DISCUSS ENVIRONMENTAL RESEARCH NETWORKS. THIS PROGRAM IS OF GREAT INTEREST TO THE NATIONAL PARK SERVICE SINCE THE USE OF PARKS FOR SCIENTIFIC PURPOSES, INCLUDING ENVIRONMENTAL EDUCATION, RESEARCH AND MONITORING, IS PART OF THE BASIC MISSION OF THE NATIONAL PARK SERVICE.

IT IS THE POLICY OF THE NATIONAL PARK SERVICE THAT INASMUCH AS: "NATURAL AND SOCIAL SCIENCE INFORMATION IS NECESSARY FOR THE MANAGEMENT OF THE NATIONAL PARK SYSTEM; THE NATIONAL PARK SERVICE WILL CONDUCT A PROGRAM OF NATURAL AND SOCIAL SCIENCE, FOR THE PURPOSE OF SUPPORTING MANAGEMENT IN CARRYING OUT THE MISSION OF THE SERVICE BY PROVIDING DECISION ASSISTANCE IN ALL ASPECTS OF PLANNING, DEVELOPMENT, AND MANAGEMENT OF THE UNITS OF THE SYSTEM."

"THE SERVICE ALSO ENCOURAGES THE USE OF PARKS BY OTHERS FOR SCIENTIFIC STUDIES WHEN SUCH USE SHALL BE CONSISTENT WITH THE PURPOSES FOR WHICH THE PARKS WERE ESTABLISHED."

THE ENTIRE SYSTEM OF NATIONAL PARKS, MONUMENTS AND RECREATION AREAS SERVES AS A NETWORK OF RESEARCH RESERVES WHICH ARE PROTECTED IN PERPETUITY, IN ACCORDANCE WITH THE ORGANIC ACT OF AUGUST 1916, WHICH CALLS FOR THE PARKS TO BE MAINTAINED "UNIMPAIRED FOR FUTURE GENERATIONS."

THE ANNUAL REPORT OF THE CHIEF SCIENTIST OF THE NATIONAL PARK SERVICE FOR 1975 LISTS 1,271 NATURAL AND SOCIAL SCIENCE PROJECTS WHICH WERE ONGOING IN THE PARK SYSTEM DURING THE CALENDAR YEAR.

RESEARCH IN THE PARKS IS CONDUCTED BY SERVICE AS WELL AS NON-SERVICE SCIENTISTS AND FALLS INTO THE FOLLOWING CATEGORIES: RESEARCH ON ANIMAL SPECIES, GEOLOGY, PLANTS AND VEGETATION, GENERAL ECOLOGY, FRESHWATER BIOLOGY, HUMAN IMPACT, MARINE STUDIES, HYDROLOGY, SOCIOLOGY, FIRE ECOLOGY, METEOROLOGY AND OTHER MISCELLANEOUS TOPICS.

IN GENERAL, INDEPENDENT INVESTIGATORS TEND TO WORK IN PARKS WHERE STRONG SERVICE-SUPPORTED RESEARCH IS GOING ON, PARTLY BECAUSE OF THE INFORMATION BASE AVAILABLE FOR THEIR OWN STUDIES AND PARTLY BECAUSE OF THE ENHANCED CAPABILITY FOR LOGISTICAL SUPPORT AVAILABLE IN PARKS WITH STRONG RESEARCH PROGRAMS.

SERVICE-CONDUCTED RESEARCH IN THE NATIONAL PARKS IS PERFORMED TO SUPPORT THE BASIC MISSION OF THE PARKS AS OUTLINED IN THE GENERAL MANAGEMENT PLAN FOR THE PARK, THE PARK'S STATEMENT FOR MANAGEMENT, THE RESOURCES MANAGEMENT PLAN, THE INTERPRETATIVE PLAN, AND THE VISITOR USE PLAN.

RESEARCH IN THE PARKS IS AIMED AT RESOURCE PRESERVATION AND MANAGEMENT, INTERPRETATION OF THE PARKS TO THE VISITING PUBLIC AS A MEANS OF ENHANCING VISITOR EXPERIENCES IN THE PARKS. FOR THE MOST PART, THE ENABLING ACTS ESTABLISHING THE PARKS CALL FOR THE PRESERVATION OF THE NATURAL VALUES OF THE PARKS, BY GENERALLY CALLING FOR THE MAINTENANCE OF

THE PARK IN ITS NATURAL CONDITION. THIS IS INTERPRETED IN THE MANAGEMENT POLICIES OF THE NATIONAL PARK SERVICE TO MEAN THE MANAGEMENT OF THE PARKS TO MAINTAIN THE NATURAL ECOSYSTEM PROCESSES WHICH IN TURN PRODUCE THE "WONDERS AND CURIOSITIES" FOR WHICH THE PARKS ARE NOTABLE.

THE CURRENT EFFORTS IN THE NATURAL LANDMARKS PROGRAM OF THE NATIONAL PARK SERVICE ARE TO IDENTIFY OUTSTANDING NATURAL AREAS IN ALL THE PHYSIOGRAPHIC PROVINCES AND VEGETATION TYPES OF THE UNITED STATES FOR POSSIBLE RECOGNITION AS NATIONAL NATURAL LANDMARKS OR FOR RECOMMENDATION FOR INCLUSION IN THE NATIONAL PARK SYSTEM, IN ACCORDANCE WITH THE GENERAL AUTHORITIES ACT OF 1976. IF THE PROCESS OF ROUNDING OUT THE PARK SERVICE WERE TO CONTINUE, PARKS SHOULD EVENTUALLY BE ESTABLISHED IN EVERY MAJOR PHYSIOGRAPHIC PROVINCE AND VEGETATION TYPE OF THE UNITED STATES.

THE NATIONAL PARK SERVICE IS A PARTICIPANT IN THE UNESCO MAN IN THE BIOSPHERE PROGRAM AND COOPERATES WITH MANY FEDERAL AGENCIES, UNIVERSITIES AND OTHER RESEARCH ORGANIZATIONS FOR THE PERFORMANCE OF RESEARCH IN THE NATIONAL PARKS.

The subcommittee will be adjourned until tomorrow.
[Whereupon, the subcommittee was adjourned at 12:50 p.m.]

ENVIRONMENTAL RESEARCH RESERVE NETWORKS

FRIDAY, JULY 29, 1977

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON THE ENVIRONMENT AND THE ATMOSPHERE,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. George E. Brown, Jr., chairman, presiding.

Present: Representatives Brown and Watkins.

Mr. BROWN. The subcommittee will come to order.

Today is the second day of the Environment and Atmosphere Subcommittee's hearings on environmental research reserve networks.

Yesterday we heard from representatives of the Energy Research and Development Administration and the Department of the Interior. They discussed attempts to create a network of research reserves within each agency and explained the basic levels of research which are being conducted on their lands. The examples of research reserve networks which we will be addressing today are the Biosphere Reserves and the Experimental Ecological Reserves.

The first panel today will include Mr. Tom Gilbert of the National Park Service, Dr. Stanley Krugman of the Forest Service and Mr. Oscar Olson of the Department of State. They will explain their roles in the Man and the Biosphere Program and Project 8: Biosphere Reserves. Dr. Krugman will also comment on the well-established experimental programs within the Forest Service.

Next, a panel will discuss the Experimental Ecological Reserves and the role of the Federal Committee on Ecological Reserves. We welcome Drs. Betsy Clark, John Brooks and Paul Whitson of the National Science Foundation and Dr. George Lauff from Michigan State University's Kellogg Biological Station.

Dr. Paul Risser from the University of Oklahoma and Dr. Jerry Franklin from the H. J. Andrews Experimental Forest near Corvallis, Ore., have both been involved in several attempts to create a network of research reserves. From their perspective as researchers, they will hopefully give us some recommendations regarding the advantages of the different approaches.

Finally, Dr. Lee Talbot of the Council on Environmental Quality will testify. The President has requested a task force to develop a National Heritage Trust program, and it would be constructive to the subcommittee to learn how we might be able to work together to accomplish the worthy goal of establishing a coordinated network of environmental research reserves.

I might also say the committee has considered over a period of some time, several years in fact, different mechanisms for improving the

quality of environmental research. I recognize that environmental and ecological are not synonymous, but they relate to each other, certainly. Throughout the country, we are still struggling with mechanisms to accomplish that, and these hearings will throw considerable light on one important aspect of the needs for a suitable program.

We have also been concerned with similar kinds of problems in other fields. I cite as an example, although you may not necessarily agree with me, the needs in the area of climate research, which call for coordinated global networks of information gathering systems, and for some coordinated effort to analyze this information within a systematic framework. We do not know how to accomplish this in the best way, either. We do not know how to set up a global earthquake program, for example, to enhance our ability to understand movements in the earth's crust, and take whatever suitable actions might be desirable.

In other words, there are a number of significant problems involving global phenomena which need to be organized as effectively as possible, and in a sense, what we are dealing with today sheds light on and sets in perspective all of these problems. In a sense, we are exploring the broadest of these, the concept of biospheric, ecological research, which involves all life within the thin shell that will support life on earth, so it is my hope that the record that we will create here will be one that we can refer to for assistance and wisdom in formulating approaches to solutions in a number of different areas aside from the one we are addressing most specifically.

Despite the difficulties that we will have because of the House being in session, and the attendance of other members being intermittent, I propose to start and move along as rapidly as possible, because, as I think is obvious to all of you, we have a substantial number of very able witnesses who have contributions to make, and we want to get the maximum benefit from them, within the handicaps of time pressures that we have. So, I will proceed, and we will try to make the best of the situation. I beg the indulgence of all of the people who are contributing to the hearing because of the circumstances.

Our first witness will be Mr. Vernon C. Gilbert, Associate Chief Scientist, National Park Service, and also we would like to have Dr. Stanley L. Krugman, Principal Research Forest Genetist, USDA Forest Service, and Mr. Oscar J. Olson, Jr., Executive Director, U.S. Man and the Biosphere, Department of State.

I must say, gentlemen, I am getting a tremendously useful education out of all of these presentations, and I trust that the record will enlighten a lot of other people also.

STATEMENT OF OSCAR J. OLSON, JR., EXECUTIVE DIRECTOR, U.S. MAN AND THE BIOSPHERE, DEPARTMENT OF STATE

Mr. OLSON. Thank you, Mr. Chairman. We are all learning together.

Mr. Chairman, I am Oscar J. Olson, Jr., Executive Director, U.S. Man and the Biosphere Program, Department of State, and it is a pleasure for us to be here before you this morning, particularly with my two colleagues working in the MAB program, from two agencies that have been most enthusiastic participants in the program.

Man and the Biosphere (MAB) is a UNESCO Program of environmental research, aimed specifically at finding solutions to natural resource management problems. It approaches these problems in an interdisciplinary manner, through applied research, and also has a very strong training component. It is aiming at providing useful information to resource managers, to decisionmakers.

Eighty-two countries members of UNESCO now are participating in the Man and the Biosphere Program, and I think it is worth noting that over the last couple of years, there has been a particular increase in interest in the developing countries in the program.

They are working within an international framework of some 14 project areas, which are listed in the statement, but also here one set of project areas includes the natural ecosystems, the mountains, the forests, et cetera, and another set concerns processes not tied to any particular natural geographic region.

This morning we will be interested primarily in Project 8, under which the network of Biosphere Reserves has been organized. Its official title in MAB is "conservation of natural areas and of the genetic material they contain".

Objectives which UNESCO set up for this particular project area are: to conserve for present and future human use the diversity and integrity of biotic communities of plants and animals within natural ecosystems, and to safeguard the genetic diversity of species on which the continuing evolution depends; and, second, to provide as far as is consistent with the first objective, areas, including managed or experimental areas, which may be used for ecological and environmental research including baseline studies, both within or near these reserves.

And, third, to provide facilities for education and training. Therefore, the research is a very important component, which makes this an appropriate subject for the hearings on environmental research reserves this morning.

The global network of biosphere reserves now numbers 118; some 27 countries have designated these. And almost that many again have been proposed, that are in the pipeline, under consideration.

The United States has thus far named 28 Biosphere Reserves, and you will see them, or perhaps you cannot see them on the map on the right, the blue dots. I believe you have been provided the excellent article on the U.S. Biosphere Reserve Program from Science Magazine that Dr. Franklin has written, and he is also with us this morning. That also has a map of the U.S. Biosphere Reserves.

The U.S. concept of selecting Biosphere Reserves has been one of pairing or clustering, since the program is two-pronged, conservation and research. In many cases, or in most, it brings together nearby areas, one large natural area, often a national park, for the conservation purposes, and then a nearby site with a history of research and manipulation, often an experimental forest.

Thus, it is that the National Park Service and the Forest Service together have taken the lead in developing U.S. participation in this Project 8 of Man and the Biosphere.

These two agencies have sponsored a series of regional workshops that have brought together land managers from the particular Biosphere Reserves in each region, together with scientists from these areas, bringing them together to look at possibilities for further re-

search, monitoring and training activities, using the Biosphere Reserves as sites.

I think this points also to an example of one of the great strengths of the entire Man and the Biosphere Program, the fact it is able to provide a mechanism to facilitate planning and research, bringing together representatives from many disciplines on the scientific side; bringing together the academic scientists with their counterparts in the Federal agencies, the scientists there, the administrators, and the land managers; and even among the Federal representatives, providing a facility or mechanism for collaboration in research and scientific programs.

In developing the U.S. program, it was early determined that there was a need for a basic inventory of, first of all, research already underway within the Biosphere Reserves that have been designated, and also a listing of the characteristics of those Biosphere Reserves. And so an information synthesis project was begun, and is being continued and carried out by the University of Oklahoma. Dr. Risser, who is in charge of that project, is also appearing before you this morning.

The Biosphere Reserves then, as sites representative of the various natural regions of the country, are obviously candidates for sites of baseline monitoring of pollutants in the environment. The directorate or group working with Project 8 is developing a pilot research project with EPA support on a limited number of Biosphere Reserves in order to provide a realistic and systematic approach to monitoring. Probably a likely beginning for this would be in the cluster including the Great Smoky Mountain National Park in the Southeast, and also in cooperation with the Division of Environmental Sciences of the Oak Ridge National Laboratory.

We have just received from UNESCO Headquarters in Paris, from the office concerned with the Man and the Biosphere Program, a letter asking for further cooperation on an international monitoring project for biosphere reserves.

I would like to read excerpts from this letter from UNESCO Headquarters, for the record.

[The letter follows:]

* * * We believe that the worldwide network of MAB biosphere reserves could be effectively utilized for environmental monitoring, particularly for both research into monitoring methodology and for the measurement of baseline values of ecologically significant variables * * *. In view of the great deal of monitoring experience in the United States, and the considerable interest in the biosphere reserve concept which has been shown by the U.S. MAB Programme, we would like to explore the possibilities of utilizing this experience and interest to help us launch an active international programme of monitoring in biosphere reserves * * *. In this respect, we would like to propose a small workshop, convened somewhere in the United States, with the participation of specialists from the United States, UNEP, and up to 5 or 6 from other countries, to draw up a concrete and realistic action plan for this activity.

Mr. Olson. We will of course be responding very positively to that letter.

Mr. Brown. May I comment on that, Mr. Olson.

We have been concerned for some time about the need for a comprehensive improved monitoring system on a very broad basis, as far as the urgent environmental pollutants are concerned, in both water, air, soil, and any place else it might happen to occur. We have been groping for some way in which the committee and the Congress could facilitate the development of this system.

We have had the Library of Congress survey the literature and offer suggestions, and one of their suggestions made a year or so ago was the convening of some sort of a seminar, similar to what you are suggesting. I would hope that you would proceed with this kind of a project, and that we could be kept informed as it progresses.

I think it would help us in our thinking about what kind of legislative support needs to be given to these concepts. We are particularly aware of the leadership that the United States can play in the international monitoring sphere, and in assisting underdeveloped countries in this kind of program, so we think it is an important initiative, one that the State Department ought to be and probably is well aware of, as a way of enhancing our role in the world community.

Mr. OLSON. Yes, and as I had indicated, the developing countries are more and more looking to the Man and the Biosphere Program in UNESCO as an opportunity for collaboration, and for learning and cooperation with the more advanced countries.

Mr. BROWN. They suspect we are monitoring in their countries anyway, so we might as well do it in a proper fashion.

Mr. OLSON. That we can more easily share.

In closing, I simply agree, Mr. Chairman, with the characterization of the Man and the Biosphere Program that appeared in a recent article in the New York Times, concerning the Biosphere Reserves, and that was to the effect that the program does indeed have an ambitious goal, and that is to keep the Earth fit for human beings and for nature.

The program has garnered increasing scientific and political support around the world, I believe, because basically it goes beyond existing programs and natural reserves, natural parks, and the like, both by emphasizing research as well as conservation and by providing international exchange of information and personnel.

Thank you very much.

Mr. BROWN. All right. Do you other two gentlemen wish to offer your comments at this time?

STATEMENT OF VERNON C. GILBERT, ASSOCIATE CHIEF SCIENTIST, NATIONAL PARK SERVICE

Mr. GILBERT. Yes, sir, I would, particularly in relationship to the Biosphere Reserve effort in developing countries.

One very significant program here in the United States is the Smithsonian Peace Corps program. In the Biosphere Reserves in the United States we are planning programs to train Peace Corps volunteers in such things as resource management and environmental research and monitoring. This training will be put to good use in the parks and reserves in developing countries.

In this program there are currently 227 volunteers assigned to natural resources and environmental projects, working in the developing countries, and there will be 150 more placed by the end of October. I think this has been an extremely significant effort, and another example of cooperation among Government agencies here.

One other thing I would like to mention, I got a call just the other day from the executive director of the Canadian program, Dr. Patricia Roberts Pichette. She said that Canada is finally establishing their first Biosphere Reserve, and they hope by the next meeting of the International Coordinating Council of Man and the Biosphere which

will be held in October, that Canada will have three or four Biosphere Reserves, and we hope to plan cooperative projects with them in the next year.

Thank you, sir.

Mr. BROWN. Thank you very much.

STATEMENT OF DR. STANLEY L. KRUGMAN, PRINCIPAL RESEARCH FOREST GENETICIST, USDA, FOREST SERVICE

Dr. KRUGMAN. Mr. Chairman, I would like to cover very briefly some aspects of the domestic program, and, if I may, relate our program to that information that we heard yesterday.

I think perhaps there are some linkages that would be useful. The whole benefit of the "Man and the Biosphere" Program in the United States is, of course, to bring together diverse groups working in some common format.

Now, as we notice from yesterday's testimony, most of the agencies are mission-oriented, with certain constraints, both congressional and Presidential, which means that only a certain amount of information can be obtained, and that limits their programs. But under this program (MAB), we have an opportunity to bring agencies together, as well as nonagency personnel, which is equally as important, that is, the university communities, State, and private individuals.

In developing our program, we have held a series of regional workshops to determine priorities, directions, and goals for each region of the country.

To date we have held three such regional workshops, starting in the East, in the West, in the Southwest, and very shortly in the Rocky Mountains.

For instance, in the Eastern program, which involves the eastern forest biosphere, which includes, Coweeta Experimental Forest, North Carolina, the Forest Service, and the Great Smoky Mountains National Park, the Park Service, colleagues from a number of universities and our ERDA colleagues joined us in a regional meeting, because the land problems and issues are very common.

We each have something to contribute. In the Pacific Northwest, we have a different mix of people, different interests, and somewhat different problems, and that is one of the advantages of the programs, in that for each region, we can bring together on a continual basis, or even on a temporary basis, certain groups to address limited or long-term problems.

Now, in relationship to some of the issues that were brought up yesterday, for instance, ERDA is interested of course in tropical forestry.

The particular area that they are interested in happens to be administered by the U.S. Forest Service, it happens to be an experimental forest, it happens to be a Biosphere Reserve, the Laquillo Experimental Forest, Puerto Rico.

It is available right now, research is going on, and there is no administration edict that is necessary to make it part of a larger program.

The philosophy, the policy, and the legal aspects say it is available for research.

Now, if we go into the coal mining regions, where land ownership is a different problem, we have had agencies that administer land, which have no research capabilities, or limited research capabilities.

Even these agencies can participate in the biosphere research program, by making the lands available, and they have a say in the type of research that is gathered on such lands, so now we have a device to bring all of the land use agencies into a program.

Likewise, we have agencies that monitor, but have no lands essentially, like EPA.

They are participants in this MAB program. In fact, within the last month, we were in Las Vegas for viewing a prototype monitoring system for environmental monitoring which EPA would like to field test, and what we offered to them of course was two Biosphere Reserves, which they did not have.

In this case, the Great Smoky Mountains National Park in the East, and the H. J. Andrews Experimental Forest in the West. So now we have an agency, EPA, with really very good capabilities for monitoring, working with two agencies, Park Service and Forest Service, which have biological expertise. Finally, to answer the question, are we reinventing the wheel? As I mentioned earlier, one of the first projects funded under the MAB program, was to answer that very question, and Dr. Risser can give more details. The very first thing we wanted to know was what information was available to the Biosphere Reserves, what kind of information we could link with it, and what kind of information is needed, and that study has been underway for about a year.

Thank you.

Mr. BROWN. Thank you very much.

You mentioned a couple of areas of importance to us, that of EPA monitoring, which we debated more than almost anybody else in this committee, in order to come up with an absolutely precise, comprehensive, detailed, monitoring system for every known pollutant, so that we could answer the most intricate questions about the dose responses of pollutants. We recognize that we are asking the impossible, but try to keep the pressure to move forward in this area.

In the situation you described, was the air monitoring system a part of it?

Dr. KRUGMAN. That is right. Their charter and mandate requires them to do certain monitoring. Monitoring can mean various things to different people. Monitoring to be useful has to be related to something. What we can offer them is mixing their scientists with biologists, with foresters, with ecologists, with fishery experts, in such a way we can assist them in the monitoring process, and interpreting this data.

Now, it was a selfish move. They have the expertise in monitoring, and this would provide our Biosphere Reserves with a unique information platform, which we have no capabilities of doing now.

Mr. BROWN. Well, the technology of monitoring is rapidly evolving. I am sure this is no secret to all of you, but from the standpoint of our concern about EPA's monitoring, we want EPA to have economical, preferably automated data gathering and monitoring systems for at least a major control pollutant program. This includes a lot of pollutants in southern California and probably in most other areas also, and it seems to me, that this is at least close enough to what your programs require for there to be a considerable amount of close cooperation between the two agencies and the two programs.

Dr. KRUGMAN. What we have to be careful in understanding is that each agency wants to essentially monitor something different, to meet their requirements.

There is no common parameter that all agencies will be interested in, nor should we expect it.

Once we accept this, then we can assume there are some common parameters that the various agencies will be interested in. In addition, there are some parameters to be measured that a given agency probably does not even know about, yet they should be interested in. They will do their monitoring, but they will do it under some constraint. Where the information is available, agencies will use it. The important thing is that agencies are looking for better ways of obtaining the data. They want to develop information, monitoring systems that give data that is useful to a given agency.

Mr. BROWN. Well, the tricky problem is to pull together the language that the diverse groups have used into a common format. Each agency does its own thing, in conformity with its own mission requirements, yet the wider needs of the global community must be integrated out of these diverse mission objectives. This is the difficult problem, one of the problems I referred to in my initial remarks, which occurs in other areas.

It may be a wide variety of institutions, organizations, collecting bits and pieces, together they constitute the whole, but how do you get them brought together, and this is one of the interesting aspects of your program.

You are apparently seeking to bring them together into a format that would be usable for all practical purposes.

Dr. KRUGMAN. To answer the first part of that reply, obviously, if you are going to do this, an agency will give up something to get something.

That is the real world we live in, but that is to our benefit.

For example, an agency like mine, the U.S. Forest Service, we have certain expertise, that we can offer, but in return, we are getting other expertise that supplements ours, and for that reason, everybody benefits.

Mr. BROWN. Why do you make it so difficult for ERDA to buy your land, so they can have control over it?

Dr. KRUGMAN. Well, I would love to answer that. I have to be careful. I do not really represent the Forest Service here in policy matters obviously.

That is an internal decision with ERDA, not with the Forest Service.

Let us be realistic. ERDA and the Forest Service scientists have a long history of working together. There is no problem here.

The buying of the land, the controlling of sovereignty of land is an internal problem within ERDA, not with us, although I am sure we may have some similar problems.

The land is available to be used, but as every agency obviously wants to be the leader, and perhaps this is ERDA's hangup, I don't know, that is their decision.

Mr. BROWN. I will not explore the details of that particular matter, but in the long run, do you think that the sharing of the use of the land despite who has sovereignty over it is a problem that will cause extreme difficulty?

Dr. KRUGMAN. Well, I don't know why we should have additional problems, because the philosophy in agencies, the Forest Service is also a landowning agency, and it has a long history——

Mr. BROWN. The Forest Service, yes.

Dr. KRUGMAN. Forest Service has the philosophy of sharing its resources, the Park Service is the same way, and the key here of course is to demonstrate the benefits of a program to the agency.

As far as the Forest Service, the Park Service, BLM, and a number of other service agencies are concerned, the benefits of this effort far outweighs any irritants on landownership.

We share staff, we share information, facilities, and it has worked out very well, and I certainly believe that this type of working relationship above the scientific level of ERDA, could easily be installed, because the scientists are already an integral part of our team.

This is not a problem.

Mr. BROWN. It seems that one ingredient in getting that kind of cooperation at the administrative level, which I suspect is more common at the scientific level, is to have a highly visible and high level of support for their problem.

Dr. KRUGMAN. That is right.

Mr. BROWN. This would assist in expediting and enhancing the cooperation.

Let me ask each of you one question about resources, which is the common denominator to all of the programs. How do you budget for this program, and what difficulties do you have with regards to the level of research activities?

There are two aspects of this, the selection of the sites, and the landowning agencies. There is not a budgetary problem, in buying the land, since they have it as part of their inventory, but this land alone is of no value without the scientific program that goes with it, and this takes considerable resources, depending on the scope of the program.

How do you handle this? Do you in the State Department have a line item budgeted for this program?

Mr. OLSON. No, Mr. Chairman, but the State Department has provided the basic administrative support. These are operational funds for the organization of the Man and the Biosphere Committee and the committee substructure, providing travel funds for bringing the groups together for setting research priorities and developing projects. This would include the regional travel expenses for the non-Federal participants in the regional meetings that were mentioned.

This amounts to, for this fiscal year, approximately $130,000, mostly from the Department of State, but also a contribution from ERDA, as an indication of their interest in the program.

The other agencies that are participating in the program also have contributed significantly in detailing personnel to the coordinating staff, so that at the present time, we have on detail professional program coordinators from the National Science Foundation, from the Forest Service, and from EPA. We have, as well as have had in the past, staff detailed from the National Park Service and ERDA, so that is an important contribution.

As far as the research budget for MAB, the projects that have been developed through the MAB mechanism, we have had informal discussion with the Office of Management and Budget, as to an appropriate agency to be a lead agency for such a research program.

We have also been talking to the Department of Interior as the program puts heavy emphasis on resource management. The Department of Interior appears to be an appropriate candidate for the lead agency, and there is a considerable interest in the program in the Department of Interior, so that these discussions concern a possible line item for support of research, in fiscal year 1979.

This would entail proposals of approximately $5 million for the Biosphere Reserve aspects of the program, which would be a little bit more than a quarter of the entire program, of the other project areas which tie in closely with project 8.

Mr. BROWN. In your agencies, the Forest Service and the Park Service, is there any separate funding for this, or does it fit into your general research activities?

Mr. GILBERT. It is fitted into our general research activities.

There has been some money made available in the National Park Service for special projects such as Dr. Risser's project, and that will be extended to help in the near future.

Mr. BROWN. Thank you very much, gentleman. I have enjoyed the testimony, and I would like to explore it in much greater detail, but as you understand, we have to move along.

Mr. OLSON. Thank you.

[The prepared statements of Mr. Olson and Mr. Gilbert follow:]

BIOSPHERE RESERVES AND THE
MAN AND THE BIOSPHERE PROGRAM (MAB)

Statement for the
Hearings on Environmental Research Reserve Networks

Subcommittee on the Environment and the Atmosphere

July 29, 1977

Thank you, Mr. Chairman, for this opportunity to appear before the Subcommittee today. I am Oscar J. Olson, Jr., Executive Director of the U.S. Man and the Biosphere Program and a member of the secretariat of the U.S. National Commission for UNESCO. Together with me today are two colleagues working with the U.S. Man and the Biosphere (MAB) program: Vernon C. Gilbert, Associate Chief Scientist, National Park Service, U.S. Department of Interior; and Stanley L. Krugman, Principal Research Forest Geneticist, U.S. Forest Service, Department of Agriculture.

I. Introduction:

Natural areas and the genetic resources of plants and animals they contain are dwindling rapidly throughout the world. This is a situation outside past experience which, in the short time of a few human generations, has imperiled a large proportion of the natural areas and the wild species that now remain. Protection of representative natural areas world-wide is important both for conservation of species diversity and for use as basic logistic resources for ecological research and the monitoring of man's impact upon the environment.

Sporadic efforts to "do something" about the situation are not new, but organized international activities toward corrective action are relatively recent. One major effort is the development of a world-wide netwerk of protected areas, or "biosphere reserves", for conservation of ecosystems and genetic diversity and for use in long-term programs of ecological research, monitoring, training and education. This is the focus of Project No. 8 "Conservation of Natural Areas and of the Genetic Material They Contain" of UNESCO's Program on Man and the Biosphere (MAB). MAB is an integrated series of far-reaching research and action projects concerned with the management of natural resources. Eighty-two countries are now cooperating under the MAB Program in an interdisciplinary approach to solving problems of common concern. The major MAB Project Areas and their current emphasis in the United States are identified in Attachment 1.

MAB Project 8 or the "Biosphere Reserve Program" has the following broad objectives:

1. To conserve for present and future use the diversity and integrity of biotic communities of plants and animals within natural ecosystems and to safeguard the genetic diversity of species on which their continuing evolution depends;

2. To provide, so far as is consistent with (1), areas including managed or experimental areas, which may be used for research, both within or near such reserves;

3. To provide facilities for education and training.

Specific biosphere reserve objectives related to the hearings on environmental research reserve networks are:

a. to provide better understanding of changes in structure and function of ecosystems which are developing under natural conditions. This information will provide baseline conditions to be compared to man-modified or experimental reserve systems within the biosphere reserve network.

b. to maintain records over time and space for answering questions currently of interest (e.g. pollutants, human use, climatic change) and as a basis for early warning of both local and global impacts now foreseen poorly, if at all.

II. Status of MAB Project 8 Internationally

As of July 1977, considerable progress has been made toward the development of the world network of Biosphere Reserves. One hundred and eighteen areas have been officially recognized by UNESCO thus far of a total of more than 200 proposed for Biosphere Reserve status by some 40 countries. Several countries in implementing their national programs also have entered into bilateral and regional cooperative projects. The 1974 agreement between the U.S.A. and the U.S.S.R. is one example, where particular emphasis is being placed on the utilization of biosphere reserves for monitoring and research on pollutants and on the ecological consequences of various land management practices on natural ecosystems.

UNESCO, with support from the United Nations Environment Program (UNEP), is developing a project on research, training and conservation planning in pilot biosphere reserves of arid and semi-arid zones. A pilot network of biosphere reserves in the Andean countries of South America is also being established.

A workshop was held at Side, in Turkey, in May 1977, to consider further development of the biosphere reserve network within the Mediterranean region. In October 1977, Australia and New Zealand will sponser a workshop devoted to the techniques of ecological survey and their application to establishing a network of biosphere reserves.

III. The United States Biosphere Reserve Program

A. Status of the Program

To date the United States has 28 areas officially designated as biosphere reserves (Attachment 2), which represent a significant proportion of the biogeographical regions of the United States.

The areas which have been designated biosphere reserves include, wherever possible, large natural areas paired with nearby research-rich, experimentally-oriented reserves. This was done with the recognition that problem solving potential depends upon the scientific consideration of a broad array of natural conditions, experience and expertise. Therefore, the mode of operation of the U.S. MAB Project 8 has been to develop a national program based upon activities in these reserves that involve cooperative study by concerned agencies, institutions and other elements of the scientific community.

The conceptual framework for the biosphere reserve project has been developed, and the Department of the Interior--National Park Service and the Department of Agriculture--Forest Service, co-lead agencies for the project, are conducting a series of regional workshops to initiate the process of planning research, monitoring and training activities in the U.S. biosphere reserves and to begin to develop cooperative projects with other countries. As of May 1977 three regional workshops have been completed, one for the biosphere reserves in the Eastern United States, held in Gatlinburg, Tennessee, in November 1976; one for reserves in the Southwestern United States held in Tucson, Arizona, March 1977; and one for the reserves in the Pacific Northwest held in Corvallis, Oregon, May 1977. The next workshop will be held in Boulder, Colorado in Novermber 1977 for the reserves in the Rocky Mountain region.

B. Plans for the Program

Major activities planned for the Biosphere Reserve Program are:

1. Biosphere Reserve Network Development.

The U.S. network of biosphere reserves is incomplete at this stage, and a gap remains in several biogeographical provinces including the grasslands and Sonoran Provinces, the north-central

part of the Eastern Forest Province and generally in the coastal and marine areas of the U.S. Therefore, additional areas must be identified and selected in these provinces, and work is progressing toward this end. The Bureau of Land Management is one agency that has submitted several candidate areas for possible n nomination as biosphere reserves. It is anticipated that a total of approximately 50 biosphere reserves would be the optimum number for the U.S. In addition, subunits may be designated as elements of a biosphere reserve cluster.

2. Resource Description and Monitoring

A basic set of studies will be conducted on each of the biosphere reserves. An inventory of what is being done in the U.S. biosphere reserves will be contained in an information synthesis project now underway by the University of Oklahoma which will compile a bibliography of information about the sites individually and collectively and summarize extant research and monitoring projects. This information synthesis project will assist biosphere reserve personnel and cooperating scientists to analyze and project the needs for research in each area, in each region, and in the U.S. network.

The basic information from each site will include composition and structure of the biological communities, such as successional patterns, age structure, population size and frequency, and ecosystem characteristics such as productivity and nutrient cycling. These results are necessary to (1) relate each site to every other site, (2) determine the degree to which data can be extrapolated to other areas, and (3) to provide a standard against which the behavior of the system can be compared, both with and without overt manipulation.

3. Development of a Pollutant Monitoring System on Biosphere Reserves

One objective of biosphere reserves will be to use selected areas as baseline monitoring sites of pollutants in the environment. This is being planned in cooperation with monitoring activities of EPA, ERDA, DOI and with the help of the Environmental Assessment Department of the Electric Power Research Institute (EPRI). This activity will aslo be done in support of the Global Environmental Monitoring Systems (GEMS) Program of UNEP. An analysis of problems associated with development of a pollutant monitoring system on international biosphere reserves has been prepared and plans are being developed for a 3-4 year pilot research program on a limited number of biosphere reserves in order to develop a

realistic and systematic approach to reserve monitoring. One area where this research is planned is the Great Smoky Mountains National Park/Coweeta Experimental Forest Biosphere Reserve Cluster in the Southeastern United Saates. This will also be done in cooperation with the Division of Environmental Sciences of the Oak Ridge National Laboratory (ORNL).

This approach to a pilot research monitoring program on selected biosphere reserves will determine the applicability, efficacy and cost-effectiveness of a variety of monitoring schemes.

C. Potential Benefits of the Program

Biosphere reserves are representative areas which demonstrate the natural dynamic equilibrium of ecosystems, and they therefore stand as benchmarks for studies of other areas over time. Synthesis of information from baseline inventories and monitoring programs in biosphere reserves, combined with modern analytical techniques, can lead to models (ranging from conceptual to mathematical) that can be used to predict the consequences of man's actions in the biosphere.

The biosphere reserve network can also bring together diffuse national and international environmental research and conservation efforts, thus reducing the unneccessary costs that occur with a number of unrelated, overlapping efforts.

Education and training programs oriented to the international biosphere reserve network and the application of research results will also help reduce costs and duplication of efforts.

The Biosphere Reserve regional workshops conducted thus far have demonstrated the prospects for marshalling the work done or currently underway by Federal agencies and universities that relates to the goals of MAB 8 and other MAB projects. For example, a considerable variety of research and monitoring is now supported by the National Park Service for direct use in its management plans. Thus, a research and management group is already present in many reserves, including monitoring capability. Other biosphere reserves (e.g. Coweeta Hydrologic Laborarory, operated by the Forest Service) have lengthy records of an environmental and biological nature. Observations of precipitation, stream flow, and other physical variables for natural and experimental watersheds at Coweeta were begun over 40 years ago. Long records such as these are vital aids in the prediction of man's effect on the environment.

Many research and monitoring efforts are being conducted by university scientists within areas now designated as biosphere reserves as well as within properties in the fringe areas of

reserve clusters. To illustrate, the contributions from Yale University, Dartmouth College, and Cornell University on the Hubbard Brook Biosphere Reserve are well-known, as are those of scientists from the University of Tennessee - Knoxville, the Oak Ridge National Laboratory (Walker Branch Watershed) and the University of North Carolina in the Great Smoky Mountains Biosphere Reserve. The past and ongoing work of these institutions contributes inventory data and research results, and their scientists and managers are contributing relevant and rigorous hypotheses about man's impact in reserves and how monitoring data can best be utilized.

IV. Outlook for the Future

At the last two General Conferences of UNESCO, where some 130 Governments were represented, there has been unanimous agreement that the MAB Program should be implemented. It is also encouraging to note that the major international organizations involved in MAB Project No. 8: UNESCO, UNEP, FAO, and IUCN, have formed an Ecosystem Conservation Group to assist in planning coordinated efforts in ecosystem conservation and research. These organizations have agreed to support the biosphere reserve project.

MAB has thus provided the first intergovernmental vehicle for bringing together diffuse national and international research, conservation, and training activities. In the United States the program has made considerable progress in the first stages of planning and development of projects. The involvement of over 150 scientists and administrators in the MAB National Committee and its project area directorates, representing some 25 government agencies and twice that number of universities, brings together a unique body of expertise to address such critical issues as the coordination of national efforts to monitor pollutants in the environment and the assessment of long-term environmental quality trends.

The Man and the Biosphere Program in general, and the biosphere reserve network project in particular, have the very real potential for developing the basis within the natural and social sciences for the rational use and conservation of the earth's natural resources and for the improvement of the global relationship between man and the environment.

THE UNITED STATES NATIONAL COMMITTEE FOR MAN AND THE BIOSPHERE

WASHINGTON, D. C. 20520

MAB PROJECT AREAS AND CURRENT EMPHASES

1. Tropical Forests: ecological effects of increasing human activities on tropical and subtropical forest ecosystems. A conceptual model for tropical forest management will be developed, using available information and defining specific inputs and outputs in ecological and economic terms.

2. Temperate Forests: ecological effects of different land uses and management practices on temperate and mediterranean forest landscapes. Baseline environmental monitoring programs and analyses of the effects of changing environmental conditions will be used to develop alternative management strategies for multiple use of temperate and mediterranean forest ecosystems.

3. Grazing Lands: impact of human activities and land use practices on grazing lands--savanna and grassland (from temperate to arid areas). The existing condition and potential of grazing lands will be determined, and physical, biological, environmental, and socio-economic effects of conflicting uses will be determined.

4. Arid Zones: impact of human activities on the dynamics of arid and semi-arid ecosystems. Causal relationships in arid land degradation will be analyzed with the view toward development of long range strategies for arid land development consistent with carrying capacities, weather conditions, and research utilization.

5. Fresh water: ecological effects of human activities on the value and resources of lakes, marshes, rivers, deltas, estuaries, and coastal zones. Research, education, and training activities will be used to develop management strategies that will provide a predictive capability for establishing the quality and quantity of water available, and identify conflicts that will arise because of limited local or regional supplies.

6. Mountains: impact of human activities on mountain and tundra ecosystems. Emphasis will be given to development of techniques for prediction of carrying capacity of mountain ecosystems for multiple use, including tourism. Analysis of the ecological and socio-economic impacts of tourism, industrial development, and resource exploitation will be examined in high latitude areas.

7. Islands: ecology and rational use of island ecosystems. Environmental and socio-economic changes associated with tourism and industrial development will be examined in order to develop improved strategies to preserve some of the features of these fragile ecosystems consistent with human needs.

8. Biosphere Reserves: conservation of natural areas and of the genetic material they contain. The 28 Biosphere Reserves established thus far in the United States are part of an international system of reserves with the primary objectives of conservation of genetic diversity, baseline environmental research and monitoring.

9. Pesticides/fertilizer: ecological assessment of pest management and fertilizer use on terrestrial and aquatic ecosystems. Included here are studies of methods of transport; behavior and reactions of specific compounds in water and terrestrial environments as related to their physical properties; protective clothing; specific formulation of pesticides to reduce environmental contamination; and disposal of contaminants.

10. Engineering works: effects on Man and his environment of major engineering works. Attention will be given to concerns which arise in a wide variety of engineering applications including: siting for environmental protection; displacement and relocation of populations including the question of equity; evaluation of effects; and improved predictive techniques to assist in decision strategies.

11. Urban ecosystems: ecological aspects of urban systems with particular emphasis on energy utilization. The initial thrust will be concerned with water management in urban systems, emphasizing human well being, land use, and energy considerations.

12. Demographic change: interactions between environmental transformations and the adaptive, demographic, and genetic structure of human populations. Two dimensions of human population change will be examined including: rural/urban migration and changes in human populations in the new and old environments; changes in health and welfare of human population in existing communities impacted by environmental change (e.g., tourism and industrial development in Samoa).

13. Perception of environmental quality: Analysis of subjectively perceived environments is necessary to understand human well being within any given environment. This project will be concerned with human perception of environmental hazards, environmental change, and environmental quality.

14. Pollution: develop a clearer understanding of the relation of pollution to the structure and functioning of terrestrial and associated aquatic ecosystems. Baseline information will be gathered through state-of-the-art measurements and observations and used to assess current environmental problems and predict future trends.

* * *

UNITED STATES BIOSPHERE RESERVES

1. Hubbard Brook Experimental Forest, New Hampshire
2. Coweeta Experimental Forest, North Carolina
3. Great Smoky Mountains National Park, Tennessee and North Carolina
4. Everglades National Park, Florida
5. Central Plains Experiment Station, Colorado
6. Big Bend National Park, Texas
7. Jornada Experimental Range, New Mexico
8. Fraser Experimental Forest, Colorado
9. Rocky Mountain National Park, Colorado
10. Yellowstone National Park, Wyoming, Idaho and Montana
11. Coram Experimental Forest, Montana
12. Glacier National Park, Montana
13. Desert Experimental Range, Utah
14. Organ Pipe Cactus National Monument, Arizona
15. Stanislaus Experimental Forest, California
16. Sequoia-Kings Canyon National Parks, California
17. H.J. Andrews Experimental Forest, Oregon
18. Three Sisters Wilderness, Oregon
19. Olympic National Park, Washington
20. Cascade Head Experimental Forest and Scenic-Research Area, Oregon
21. San Joaquin Experimental Range, California
22. San Dimas Experimental Forest, California
23. Channel Islands National Monument, California
24. Noatak National Arctic Range, Alaska
25. Mt. McKinley National Park, Alaska
26. Aleutian Island National Wildlife Refuge, Alaska
27. Luquillo Experimental Forest, Puerto Rico
28. Virgin Islands National Park, Virgin Islands

STATEMENT BY THE DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE, BEFORE THE SUBCOMMITTEE ON THE ENVIRONMENT AND ATMOSPHERE, HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY ON ENVIRONMENTAL RESEARCH NETWORKS.

July 28, 1977

MR. CHAIRMAN, IT IS A PRIVILEGE FOR ME TO APPEAR BEFORE YOU TO DISCUSS ENVIRONMENTAL RESEARCH NETWORKS. THIS PROGRAM IS OF GREAT INTEREST TO THE NATIONAL PARK SERVICE SINCE THE USE OF PARKS FOR SCIENTIFIC PURPOSES, INCLUDING ENVIRONMENTAL EDUCATION, RESEARCH AND MONITORING, IS PART OF THE BASIC MISSION OF THE NATIONAL PARK SERVICE.

IT IS THE POLICY OF THE NATIONAL PARK SERVICE THAT INASMUCH AS: "NATURAL AND SOCIAL SCIENCE INFORMATION IS NECESSARY FOR THE MANAGEMENT OF THE NATIONAL PARK SYSTEM; THE NATIONAL PARK SERVICE WILL CONDUCT A PROGRAM OF NATURAL AND SOCIAL SCIENCE, FOR THE PURPOSE OF SUPPORTING MANAGEMENT IN CARRYING OUT THE MISSION OF THE SERVICE BY PROVIDING DECISION ASSISTANCE IN ALL ASPECTS OF PLANNING, DEVELOPMENT, AND MANAGEMENT OF THE UNITS OF THE SYSTEM."

"THE SERVICE ALSO ENCOURAGES THE USE OF PARKS BY OTHERS FOR SCIENTIFIC STUDIES WHEN SUCH USE SHALL BE CONSISTENT WITH THE PURPOSES FOR WHICH THE PARKS WERE ESTABLISHED."

THE ENTIRE SYSTEM OF NATIONAL PARKS, MONUMENTS AND RECREATION AREAS SERVES AS A NETWORK OF RESEARCH RESERVES WHICH ARE PROTECTED IN PERPETUITY, IN ACCORDANCE WITH THE ORGANIC ACT OF AUGUST 1916, WHICH CALLS FOR THE PARKS TO BE MAINTAINED "UNIMPAIRED FOR FUTURE GENERATIONS."

THE ANNUAL REPORT OF THE CHIEF SCIENTIST OF THE NATIONAL PARK SERVICE FOR 1975 LISTS 1,271 NATURAL AND SOCIAL SCIENCE PROJECTS WHICH WERE ONGOING IN THE PARK SYSTEM DURING THE CALENDAR YEAR.

RESEARCH IN THE PARKS IS CONDUCTED BY SERVICE AS WELL AS NON-SERVICE SCIENTISTS AND FALLS INTO THE FOLLOWING CATEGORIES: RESEARCH ON ANIMAL SPECIES, GEOLOGY, PLANTS AND VEGETATION, GENERAL ECOLOGY, FRESHWATER BIOLOGY, HUMAN IMPACT, MARINE STUDIES, HYDROLOGY, SOCIOLOGY, FIRE ECOLOGY, METEOROLOGY AND OTHER MISCELLANEOUS TOPICS.

IN GENERAL, INDEPENDENT INVESTIGATORS TEND TO WORK IN PARKS WHERE STRONG SERVICE-SUPPORTED RESEARCH IS GOING ON, PARTLY BECAUSE OF THE INFORMATION BASE AVAILABLE FOR THEIR OWN STUDIES AND PARTLY BECAUSE OF THE ENHANCED CAPABILITY FOR LOGISTICAL SUPPORT AVAILABLE IN PARKS WITH STRONG RESEARCH PROGRAMS.

SERVICE-CONDUCTED RESEARCH IN THE NATIONAL PARKS IS PERFORMED TO SUPPORT THE BASIC MISSION OF THE PARKS AS OUTLINED IN THE GENERAL MANAGEMENT PLAN FOR THE PARK, THE PARK'S STATEMENT FOR MANAGEMENT, THE RESOURCES MANAGEMENT PLAN, THE INTERPRETATIVE PLAN, AND THE VISITOR USE PLAN.

RESEARCH IN THE PARKS IS AIMED AT RESOURCE PRESERVATION AND MANAGEMENT, INTERPRETATION OF THE PARKS TO THE VISITING PUBLIC AS A MEANS OF ENHANCING VISITOR EXPERIENCES IN THE PARKS. FOR THE MOST PART, THE ENABLING ACTS ESTABLISHING THE PARKS CALL FOR THE PRESERVATION OF THE NATURAL VALUES OF THE PARKS, BY GENERALLY CALLING FOR THE MAINTENANCE OF

THE PARK IN ITS NATURAL CONDITION. THIS IS INTERPRETED IN THE MANAGEMENT POLICIES OF THE NATIONAL PARK SERVICE TO MEAN THE MANAGEMENT OF THE PARKS TO MAINTAIN THE NATURAL ECOSYSTEM PROCESSES WHICH IN TURN PRODUCE THE "WONDERS AND CURIOSITIES" FOR WHICH THE PARKS ARE NOTABLE.

THE CURRENT EFFORTS IN THE NATURAL LANDMARKS PROGRAM OF THE NATIONAL PARK SERVICE ARE TO IDENTIFY OUTSTANDING NATURAL AREAS IN ALL THE PHYSIOGRAPHIC PROVINCES AND VEGETATION TYPES OF THE UNITED STATES FOR POSSIBLE RECOGNITION AS NATIONAL NATURAL LANDMARKS OR FOR RECOMMENDATION FOR INCLUSION IN THE NATIONAL PARK SYSTEM, IN ACCORDANCE WITH THE GENERAL AUTHORITIES ACT OF 1976. IF THE PROCESS OF ROUNDING OUT THE PARK SERVICE WERE TO CONTINUE, PARKS SHOULD EVENTUALLY BE ESTABLISHED IN EVERY MAJOR PHYSIOGRAPHIC PROVINCE AND VEGETATION TYPE OF THE UNITED STATES.

THE NATIONAL PARK SERVICE IS A PARTICIPANT IN THE UNESCO MAN IN THE BIOSPHERE PROGRAM AND COOPERATES WITH MANY FEDERAL AGENCIES, UNIVERSITIES AND OTHER RESEARCH ORGANIZATIONS FOR THE PERFORMANCE OF RESEARCH IN THE NATIONAL PARKS.

Mr. BROWN. We have next a panel on the Experimental Ecological Reserves, made up of Dr. Eloise E. Clark, Assistant Director for Biological, Behavior and Social Sciences; Dr. John L. Brooks, Deputy Division Director, Division of Environmental Biology; and Dr. Paul D. Whitson, Staff Associate, Division of Environmental Biology, and Executive Secretary of the Federal Committee on Ecological Reserves.

We welcome you all, and look forward to your contribution.

STATEMENT OF DR. ELOISE E. CLARK, ASSISTANT DIRECTOR FOR BIOLOGICAL BEHAVIOR AND SOCIAL SCIENCES

Dr. CLARK. Thank you, Mr. Chairman. My remarks will be quite brief.

As you know, NSF has had a long-standing commitment toward strengthening scientific knowledge about the complex phenomena that occur in the environment.

The research results deriving from our programs in many fields of science have contributed substantial information over the years. Yet only recently have we begun to understand the complexities and interrelationships of environmental problems (perhaps particularly in their biological manifestations) to the degree that sophisticated and reliable methods of analysis and measurement can be directed toward testing hypotheses and theoretical concepts in these areas.

I am not an expert in the area, but from my perspective, it seems that our scientific capability in these fields must be at least an order of magnitude greater. In the biological areas, this has brought a major need for increasing research facilities, for taking more comprehensive approaches to some of the problems, and—insofar as they represent the materials and laboratory of the environmental biologists—the need for experimental sites that are representative of major ecosystem types (in some cases rare types).

I am personally pleased to participate in these hearings and to do what we can to advance our scientific understanding of environmental biology. It is our conviction that more detailed and accurate information in this area will certainly be required to provide solutions to our major societal problems.

I would like to have Dr. Brooks give some brief introductory remarks, and then be followed by Dr. Paul Whitson, who is with the Foundation on the Intergovernmental Personnel Exchange from the University of Northern Iowa, and has been very active in the Federal Committee on Ecological Reserves.

Mr. BROWN. You take them even from Northern Iowa?

Dr. CLARK. Even from Northern Iowa.

[Laughter.]

Mr. BROWN. We are happy to have both of you gentlemen here. You may proceed with your statement. I am pleased to have your optimistic assessment of the progress we are making in this area.

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Dr. CLARK. There is much to be done, though.

Mr. BROWN. It has only been, I would say probably, less than two decades that ecology and ecological research really achieved any recognition at all as a particular specialty in science.

I do not know whether the data of Dr. Odum's book is historic or not, but that is a very short time in comparison to history.

You may go ahead, Dr. Brooks.

STATEMENT OF DR. JOHN L. BROOKS, DEPUTY DIVISION DIRECTOR, DIVISION OF ENVIRONMENTAL BIOLOGY

Dr. BROOKS. Thank you, Mr. Chairman. I am pleased to have this opportunity to testify before you and the subcommittee.

Within the National Science Foundation it is the responsibility of the Division of Environmental Biology to help maintain the vigor of environmental biology in the United States.

We seek to accomplish this by providing support for projects, emanating primarily from academic institutions, on systematic and evolutionary biology of all organisms—all plants, animals, and microorganisms—and on the ecology of nonmarine parts of the living world.

NSF's Environmental Biology Division provides approximately 80 percent of the Federal support for research on these subjects at academic institutions. In addition to its research support programs, the Division provides operational support for those facilities judged by the scientific community to be of national significance.

In this connection, we made a grant in 1974 to the Institute of Ecology entitled "Needs for and Feasibility of Experimental Ecological Reserves." I might note here that The Institute of Ecology, with the acronym, "TIE," is an offshoot of the Ecological Society of America. TIE was incorporated in 1971 as an international organization committed to fostering ecological research, particularly research that is directed toward meeting human needs.

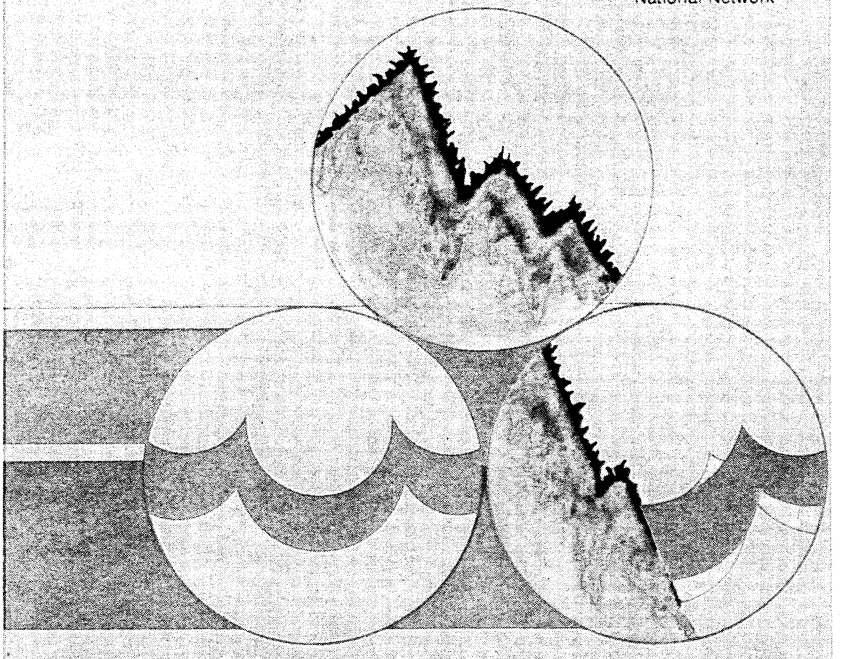
The final report of this study grant has just been printed, and copies have been provided to the members of the subcommittee. I am pleased to submit a copy of the report for the hearing record.

Mr. BROWN. We will make that an official part of the hearing record, and we are very, very pleased the report could be completed in time for submission to the committee.

[Material referred to above follows:]

Experimental Ecological Reserves

A Proposed National Network



Report Prepared for: National Science Foundation
Directorate for Biological, Behavioral and Social Sciences
Division of Environmental Biology

Summary

Man is an integral part of the environment—dependent upon managed ecosystems for sustenance and inextricably linked with all natural ecosystems.

Ecosystems are complex, interacting organizations of biological communities and other environmental factors. They are imperfectly understood. Ecosystems vary in their response to the indirect stresses and management practices which man places on them. Scientists are accumulating extensive experimental data about such effects, but what is true for one ecosystem may not apply to others. Changes in one part of an ecosystem may cause changes, often over long periods, in other parts of the ecosystem. For example, the use of DDT as an insecticide not only swiftly accomplished the intended purposes; it also caused the accumulation of DDT in other animals, with sometimes lethal results.

A network of field sites, each representative of a different ecosystem and designated for experimental research, would improve the ability of scientists to learn how various ecosystems function. Ecological research has progressed to the point that scientists can explore new frontiers in comparative ecosystem analysis, if an institutional framework for experimental sites is formed. Governmental agencies with environmental mandates frequently do not have research sites in regions where environmental problems arise. They also need a cooperative network of field sites to ensure the availability of the ecological data base and the area required for manipulative experiments. Thus a coordinated array of field research sites located in each of the Nation's ecosystems will both advance ecological knowledge and address pressing needs for environmental information to help determine the effects of man's technology and growing population.

Large research sites representative of major ecosystems and designated for manipulative research are defined in the developing system of natural land use classification as Experimental Ecological Reserves (EER). EERs complement Research Natural Areas (RNAs) in the research reserve system. While both types provide detailed information on environmental processes, RNAs are primarily intended for observational research and can serve as control sites for the long-term, manipulative experimentation provided for at EERs. The need for a national network of EERs as part of a natural areas system has been recognized in the reports of scientific societies and governmental studies, including the American Institute of Biological Sciences and the Federal Committee on Ecological Research. Several Federal agencies have begun to implement some goals of an EER network through the Federal Committee on Ecological Reserves (FCER).

This study proposes a plan for an initial network of Experimental Ecological Reserves. Task groups of scientists developed general specifications, quantified criteria and used them to select sites for the initial network. Field research facilities considered were primarily Federal, university, and private sites which now encourage or have potential for long-term experimental ecological research. Over 300 existing sites were contacted; completed inventory forms were returned for 171 sites. They provided descriptions of the site's environment and natural resources, of the research history and program quality, and of the physical facilities and technical support available. On the basis of this information, a panel of scientists judged each site with respect to existing and long-term potential for ecological research.

The initial EER network which emerged from this process includes sites in 67 locations representing a total of 71 inventoried sites in 28 States, Puerto Rico, and the Virgin Islands. These represent over half of the ecosystems in the United States and include types which cover nearly three-fourths of the land area of the contiguous United States. About half of the sites designated for the network are Federal lands managed by agencies such as the U.S. Forest Service and the Energy Research and Development Administration. Nearly 40 percent are controlled by universities. Private groups and State governments own the remainder. Ninety percent of the land area is under Federal control. University sites, however, provide one-third of the representative environments and frequently possess considerable biological diversity within a site. The emphasis of the initial EER network is terrestrial. In an expanded network, aquatic and man-managed environments should receive priority along with the terrestrial ecosystems not represented.

The largest single investment required for the network is the land which is already owned by Federal agencies or universities interested in participating. Costs to initiate the system are estimated at $37 million for capital improvements at the sites, $9.1 million in annual operating costs for the sites, and $150,000 annually for coordination. The Federal agencies and universities which own field research sites selected for the network have already spent hundreds of millions of dollars in developing long-term, experimental ecological research programs. These investments would be enhanced through a coordinated network. The estimated cost is substantially less than 10 percent of the current annual Federal expenditures for ecological research. This investment will:

1. Provide sites suitable for manipulative ecological experiments in representative ecosystems;

2. Guide financial investment in support facilities for field sites;

3. Ensure conduct of the necessary studies and monitoring to provide baseline data within which an ecosystem's responses can be evaluated;

4. Encourage coordination of the planning and the conduct of research so that the efforts of researchers can complement each other in the study of the complex patterns of ecosystems; and

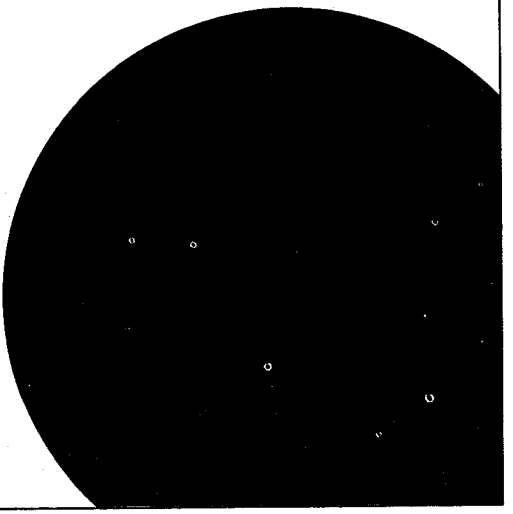
5. Improve communication and cooperation between researchers and the users of ecological knowledge.

It is urgent that an array of field sites representative of natural ecosystems be established to ensure their continued availability to the scientific community for study and research. Data acquired through experimental manipulation and long-term investigation are essential to the detailed understanding of the organization and function of ecosystems. The public's need for ecological information to improve assessment of environmental effects is recognized in legislation such as the National Environmental Policy Act. It corresponds to the need of scientists for data at the ecosystem level. By building on the synergism between these needs, the proposed network of Experimental Ecological Reserves will be an important step toward more effective contributions by the Nation's scientists and better use of the Nation's financial and natural resources.

Experimental Ecological Reserves

A Proposed
National Network

June 1977



tie
The Institute of Ecology

Foreword

The Institute of Ecology (TIE) is a nonprofit organization committed to developing ecology as a science and improving the application of ecological knowledge to policy. During its first 5 years, TIE has drawn upon the resources of its Founding Institutions, its Environmental Assembly, and cooperating organizations to convene advisory or study groups. TIE's activities have been sponsored by private foundations and government agencies.

The study on "Experimental Ecological Reserves" reflects the maturation of over a decade of thought in the scientific community of ecologists on the need for a national network of field research facilities. This EER Network is necessary both to satisfy requirements of the developing science and to enable ecologists to relate to environmental problems.

The support and cooperation of many individuals from State, private, and Federal institutions who served as panelists, correspondents, and reviewers made possible a report that reflects the views of the scientific community. The issues are timely and the need to secure representative ecosystems is urgent. This report will be widely distributed to researchers and those responsible for developing policy on the resources necessary for the continued development and application of ecological knowledge.

John M. Neuhold, TIE Director

December, 1976

Acknowledgments

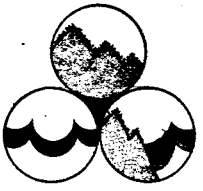
This study of the feasibility of a system of Experimental Ecological Reserves was supported by Grant No. BMS-74-20599 A01 from the Biological Research Resource Program of the National Science Foundation.

Project meetings were hosted by the Sapelo Island Research Foundation and University of Georgia Marine Institute; Oak Ridge Associated Universities in cooperation with Oak Ridge National Laboratory; and the W.K. Kellogg Biological Station of Michigan State University, which also provided support facilities for project coordination.

Responsibilities for executing the project and developing this report were assumed by George Lauff and David Reichle with the able support of Frances Irwin of The Institute of Ecology. Felix Rimberg, formerly with the Institute, contributed from the conception of the project. Brian Bedford served in a dual coordination and management capacity through the spring of 1976.

The TIE staff contributed substantially to preparation of the manuscript, particularly Jennifer Christy, Ann Matikan, and Ken Weaver. The report benefited from the editorial suggestions of Robert Burgess, Oak Ridge National Laboratory. Jerry Olson, Oak Ridge National Laboratory, provided the computer generated site location map used in preparation of the overlay map.

Jan Moody was particularly imaginative and patient in working with the Project Management in developing the format of the report.



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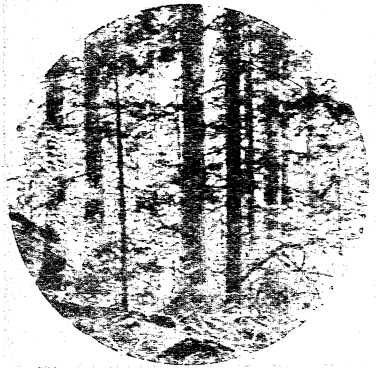
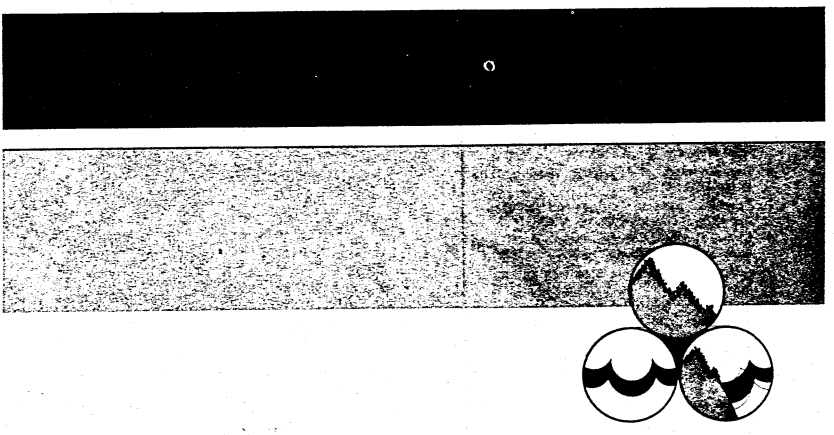


Old-growth coniferous forests are the dominant biological feature of the H. J. Andrews Experimental Forest. View of mixed stand of old-growth *Pseudotsuga menziesii* (450-years-old) and younger *Tsuga heterophylla*. *U. S. Forest Service;* Oregon.

This study develops the idea and often repeated general recommendation of a network of field research resources into a plan for an initial network of Experimental Ecological Reserves (EER). It describes the support needed to form and enhance a network of 67 existing field sites and outlines a management structure for EERs and the coordinating mechanism for the network.

An Experimental Ecological Reserve is a field site representative of an important natural system which is dedicated for long-term experimental research. This research may be directed toward study of individual species or interacting populations. It is often at the ecosystem level and usually requires manipulation of the environment. In the United States there is cooperation among experimental research sites in some States and regions, but most sites are now largely autonomous units. They are



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