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SUBJECT: Forwards marked-up maps & supplemental info re arid lands ecology reserve (ALE). ALE makes up 120 square miles of Hanford Natl Environ Research Park. Oversized map encl. Aperture card available in PDR.

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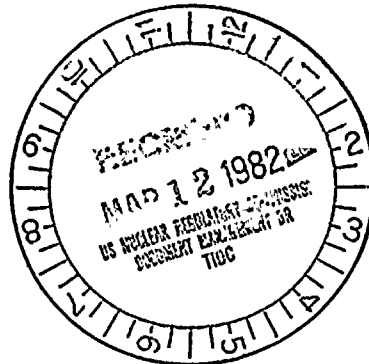
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Department of Energy  
 Richland Operations Office  
 P.O. Box 550  
 Richland, Washington 99352

MAR 1 1982



Mr. Bob Jackson, Geosciences Branch  
 Division of Engineering  
 U.S. Nuclear Regulatory Commission  
 Washington, D.C. 20555

Dear Mr. Jackson:

DEPARTMENT OF ENERGY'S ARID LANDS ECOLOGY RESERVE

In response to your recent telephone conversation with Paula Clark, two maps are enclosed showing the location of the Arid Lands Ecology (ALE) Reserve. A fact sheet and some supplemental information (Congressional testimony) on the history, nature and value of the ALE Reserve, are also enclosed.

Briefly, the ALE Reserve is an area of 120 square miles included within the 570 square miles of the Hanford National Environmental Research Park (NERP) and provides the protected landscape necessary for long-term ecological research. One of the primary aims of the ALE site is to preserve remnants of native vegetation for ecological study and as a reference point for judging long-term, slowly paced vegetational changes that are not attributed to the activities of man. For this reason, policies for the ALE Reserve are more restrictive than those for other parts of the Hanford NERP.

I hope this information meets your need..

Very truly yours,

*H. E. Ransom*

H. E. Ransom, Director  
 Energy Programs Division

EPD:PKC

Enclosures:

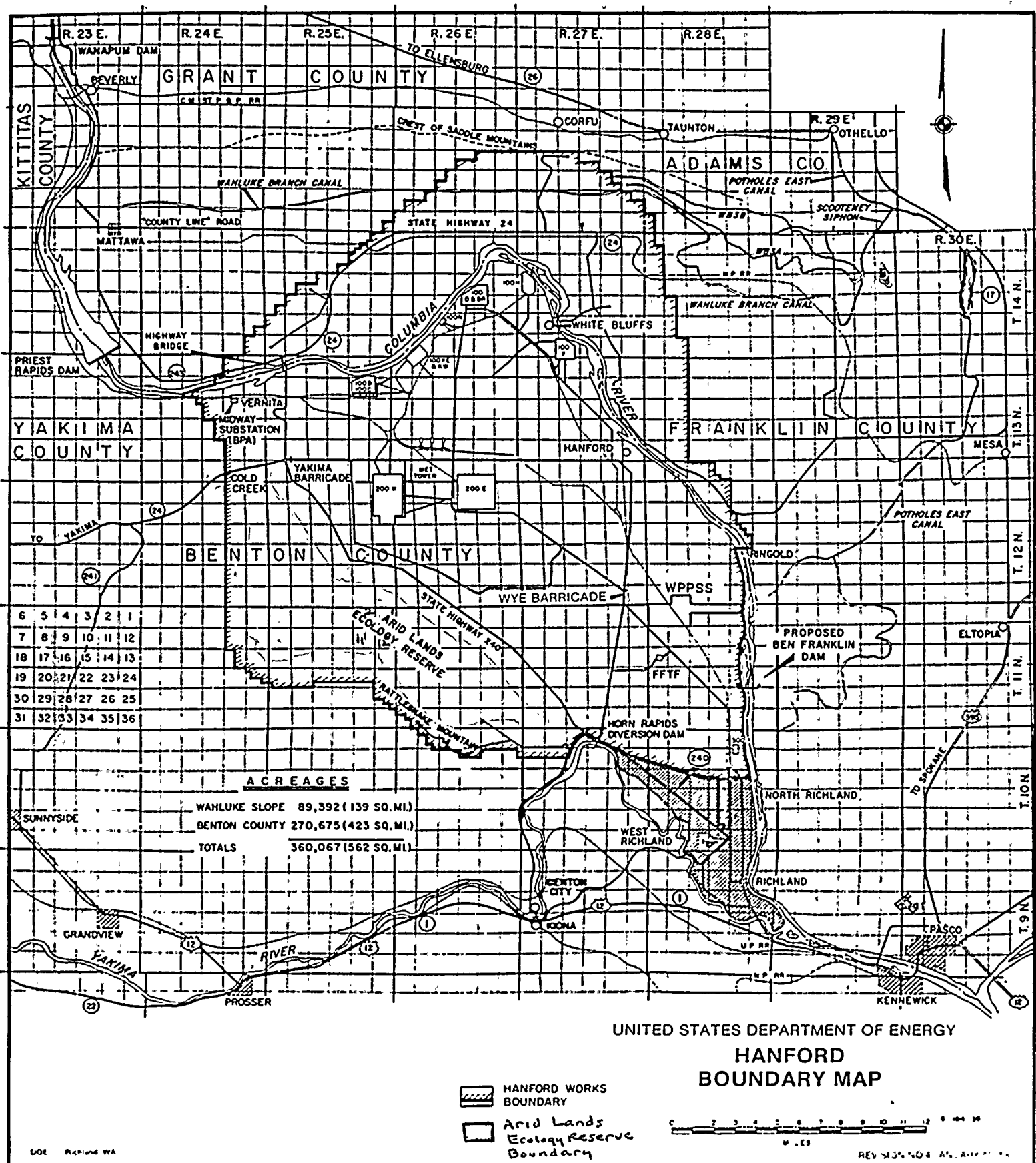
1. Hanford boundary map
2. USGS map
3. Fact sheet
4. Testimony of Burton E. Vaughan

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

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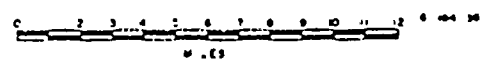


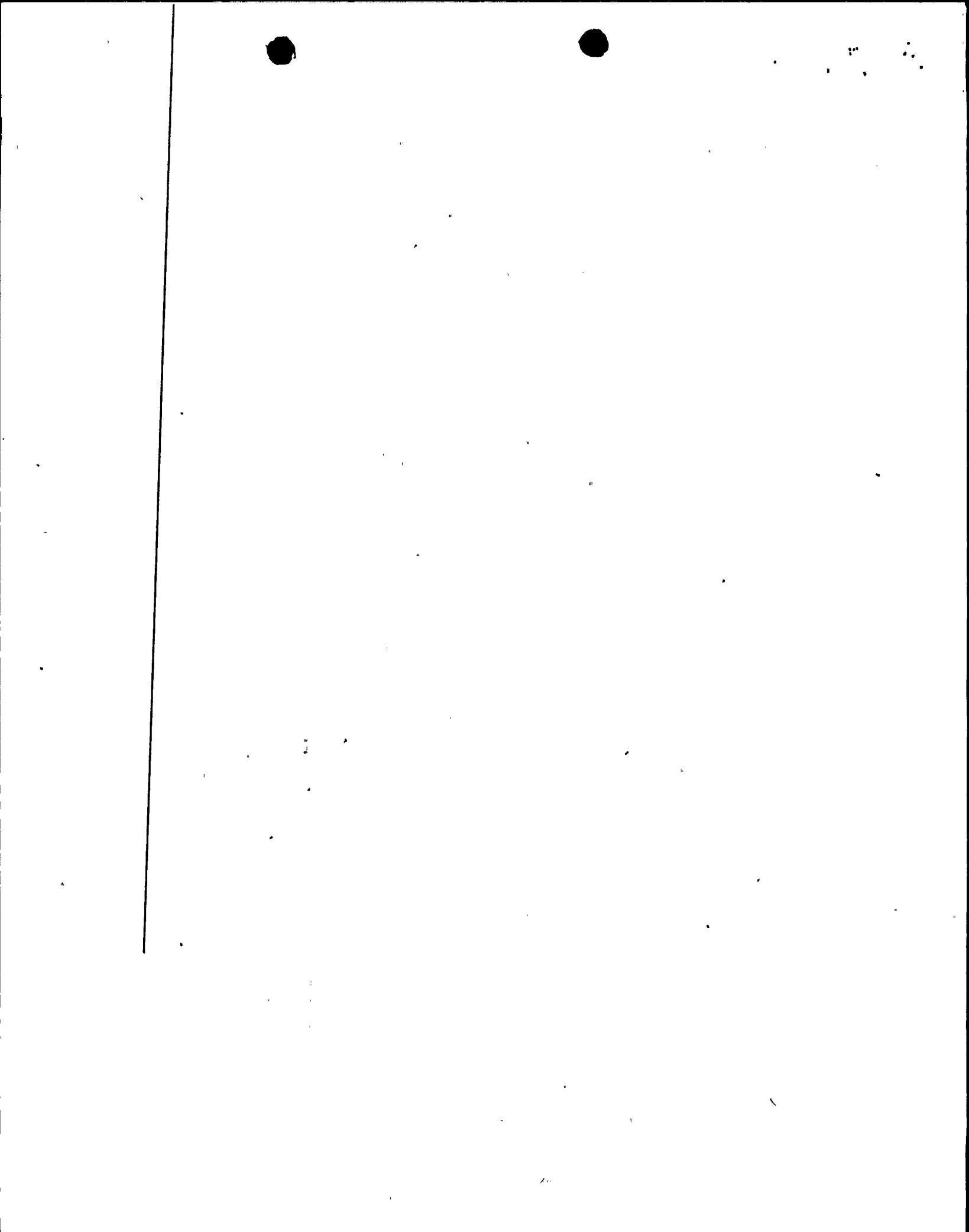
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UNITED STATES DEPARTMENT OF ENERGY  
**HANFORD**  
**BOUNDARY MAP**

-  HANFORD WORKS BOUNDARY
-  Arid Lands Ecology Reserve Boundary





Arid Lands Ecology Reserve (ALE)

Location: Hanford site, Benton County, Washington

Size: 120 square miles in the Rattlesnake Hills

Land use: Energy research and development, ecological research

Designations:

1. Rattlesnake Hills Research Natural Area, 1971, Interagency Agreement (Department of Agriculture, Department of Interior, Atomic Energy Commission)
2. Arid Lands Ecology Reserve, 1976, Atomic Energy Commission
3. National Environmental Research Park, 1977, Energy Research and Development Administration (includes ALE as well as the remainder of the Hanford site, except exclusion areas)
4. Experimental Ecological Reserve, 1976, Institute of Ecology (National Science Foundation)

Threatened species on ALE:

Animals:	Long-billed curlew	Burrowing owl
	Golden eagle	Desert night snake
	Prairie falcon	Whip snake
	Swainson's hawk	

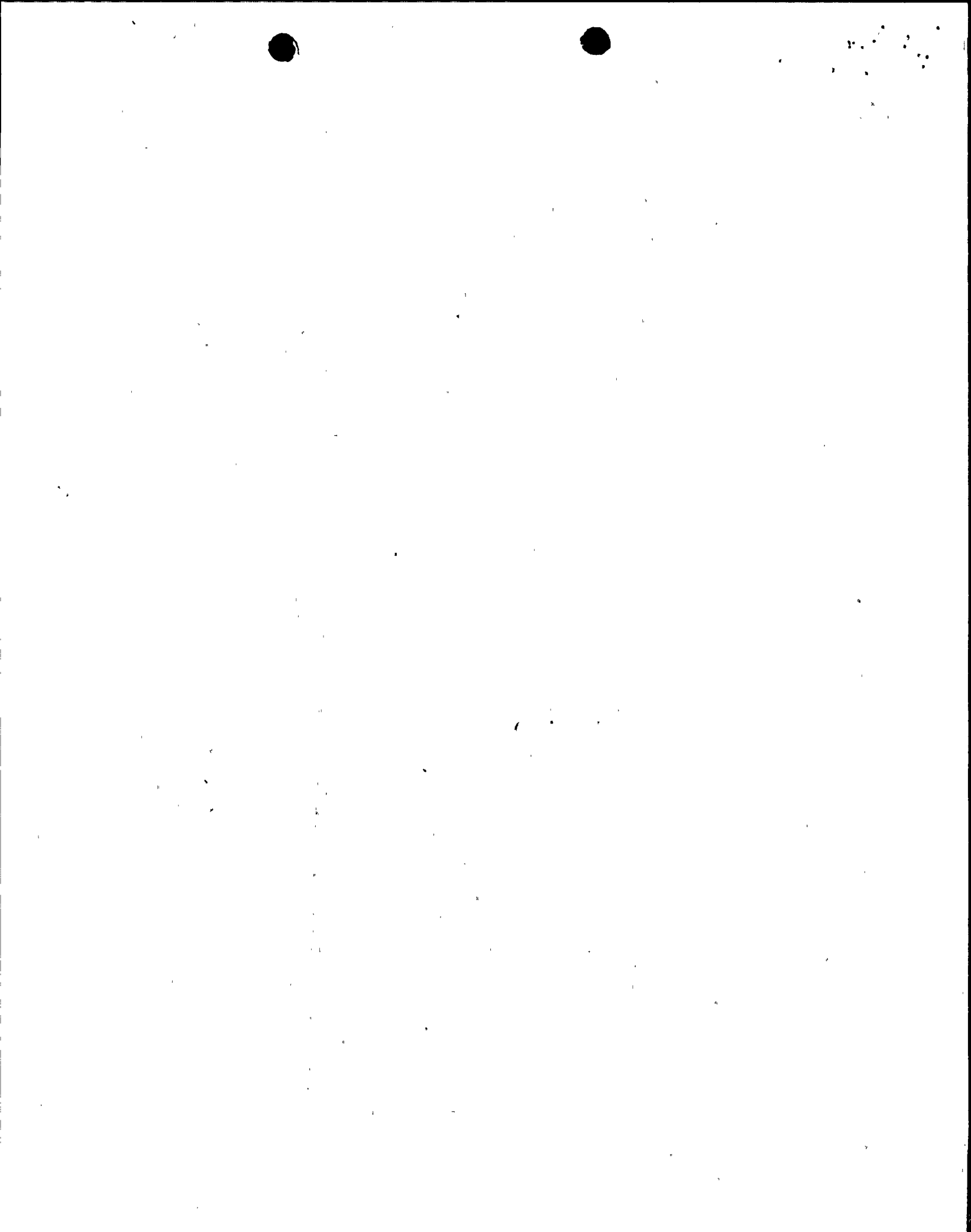
Plants: Rosy Balsamroot (*Balsamorhiza rosea*)

(There are additional threatened or endangered species, including the bald eagle, on the remainder of NERP.)

Management: The ALE Reserve is under the Jurisdiction of the Richland Operations Office, Department of Energy. Battelle Memorial Institute, as DOE contractor for operation of the Pacific Northwest Laboratory (DE-AC06-76RLO1830), has been assigned management of the Reserve.

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:

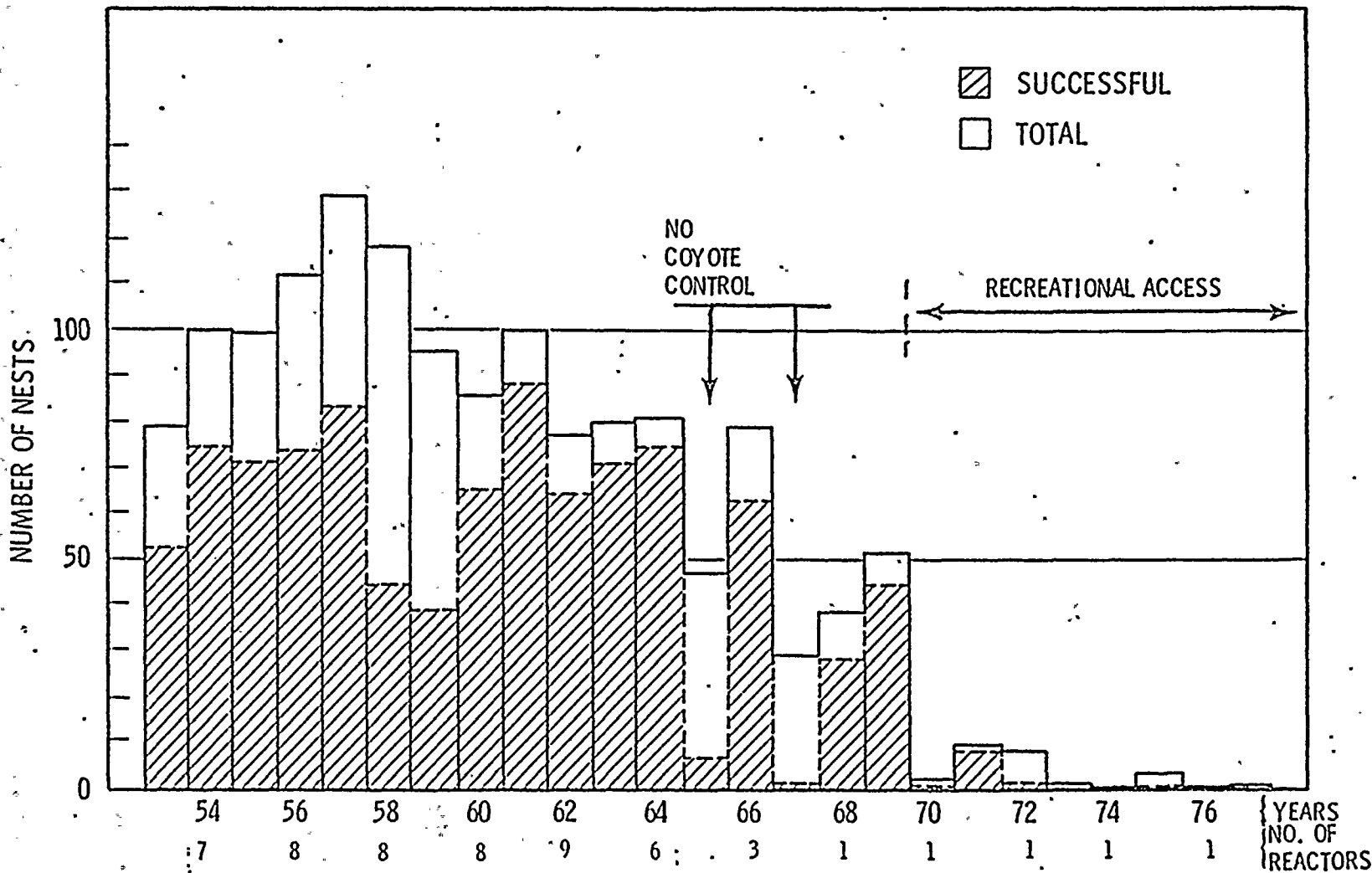
I have been asked to give my views on several questions relating to operation of the National Environmental Research Park (NERP) at Hanford, Washington (1). Although Hanford's NERP was dedicated in March 1977, major elements of the NERP Program have been in place for over a decade. The program has even 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;



**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.

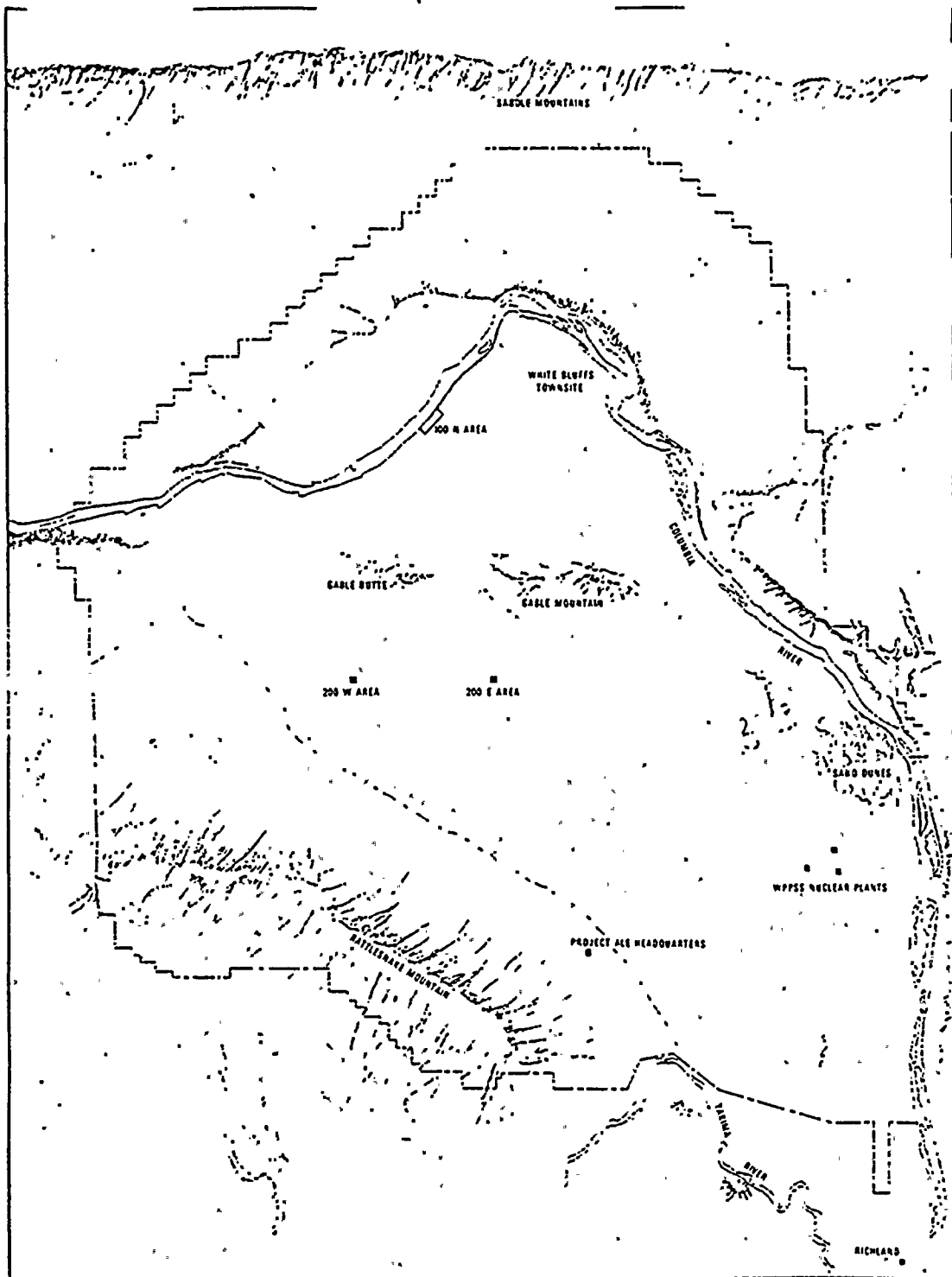
#### ARID LANDS ECOLOGY RESERVE -- RELATION TO OTHER NATIONAL SITES

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



Small, illegible markings or text in the top right corner.

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 facilities, 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





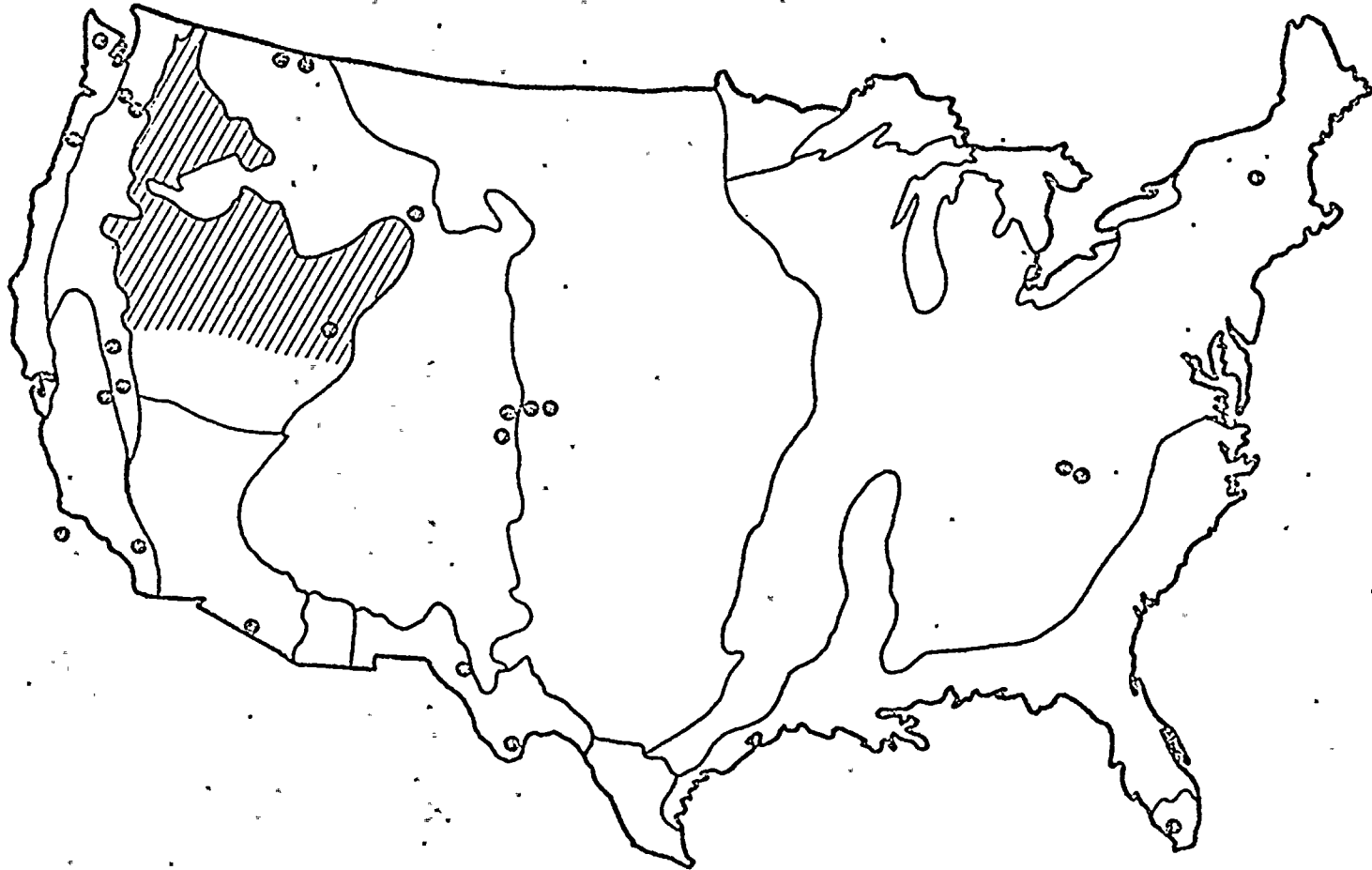


FIGURE 3. Location of Presently Established (dots) Biosphere Reserves.  
Reproduced with Permission of Science 195:263; 1977.



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 if it 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)

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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.

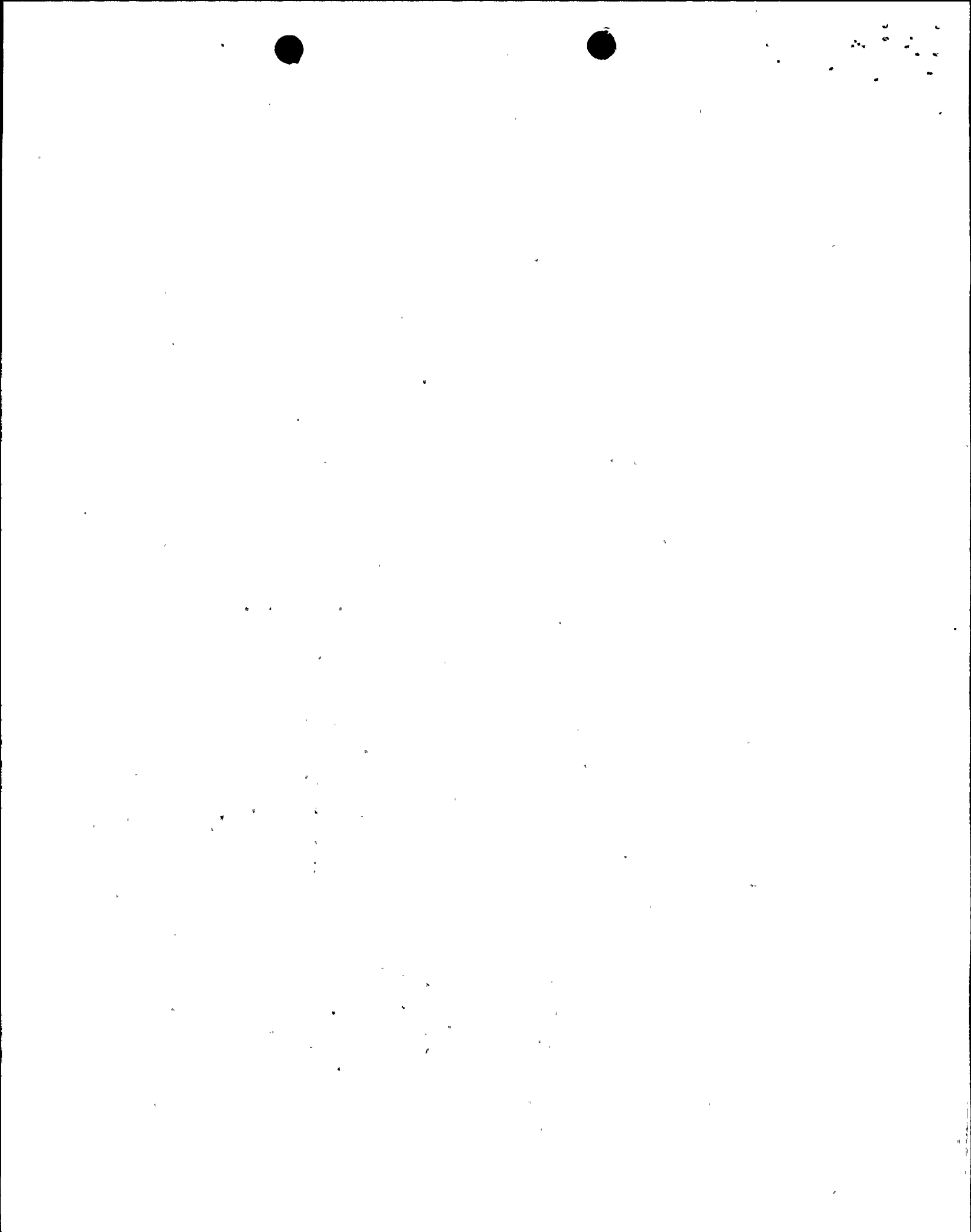
In aquatic environments, we need to know at what point pollutant burden damages either organic productivity or ecosystems structure sufficiently to render such bodies of water unsuitable either for visual esthetic or recreational purposes. Despite a good many years' research since NEPA, we often do not 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

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### 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.

