PRESIDENTIAL ADDRESS

Science and the Conservation of Our Natural Resources

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The Meaning of Conservation—

The meaning of conservation has been so segmented by pre-conceived notions that it is hazardous to attempt to focus attention upon a single interpretation acceptable to everyone.

The late Gifford Pinchot (1) described conservation as a new governmental policy that brought into close relationship such renewable resources as forests, rangelands, waters and wildlife and he advocated the need for unifying their management into a single land-use program. For the definition of conservation, however, Pinchot gave credit to Dr. W. J. McGee, head of the Bureau of American Ethnology during the administration of Theodore Roosevelt. McGee defined conservation as the use of natural resources for the greatest good of the greatest number for the longest time. This meaning of conservation holds wide acceptance even today among resource specialists.

Many other viewpoints concerning conservation have been expressed by other writers. For example, Paul B. Sears (2) said, "Conservation is not a subject, but a point of view." Writing about conservation, Aldo Leopold (2) said, "A thing is right only when it tends to preserve the integrity, stability and beauty of the community; and the community includes the soil, water, fauna and flora, as well as the people." An unknown author said, "Conservation is intelligent cooperation with nature."

The foregoing quotations are indicative of the voluminous semantics that have evolved since the turn of the century when the idea of conservation of our natural resources first was called to the attention of the American people.

The idea of conservation gained its first roots among the scientists of the nation. Colonel Richard Lieber, first director of the Indiana Department of Conservation, said, "The thought of conservation started not with the user, let alone the despoiler, but rather from the scientist's workshop." (3) The reason for *this statement* stems from the initial concern voiced by the American Association for the Advancement of Science over the loss of our nation's forest resources. In 1873, and again in 1890, the association sent memorials to Congress and to the states asking that laws be enacted for the protection of forests. In 1897, the National Academy of Sciences followed with a statement of its own concerning the protection of our natural resources.

The beginning of the conservation movement in the United States is commonly associated with the White House Conference of Governors called by President Theodore Roosevelt in 1908. Following the conference, President Roosevelt appointed a National Conservation Commission consisting of forty-nine men representing about equal numbers from the ranks of scientists, politicians and industrialists. A year later (1909), the commission submitted the first comprehensive inventory of the nation's resources. The second immediate result of the White House Conference of Governors was the appointment of state conservation agencies in forty-one of the states by governors who had come to recognize the necessity for such action.

Time does not permit a comprehensive discussion of the historical development of the conservation movement in the United States. It is sufficient to say that the scientists of the nation were among the first to become concerned about the profligate handling of the natural resources of the nation.

Conservation is often defined as the wise use of our natural resources. I should like to place greater emphasis on man's obligation with regard to such use by saying that conservation means the wise use and *management* of our natural resources to make them last for the longest possible time. Resources are of no value to man unless thay can be used. The confusion associated with the idea of conservation results largely over the controversy of opinion as to what constitutes wise use, both for the present as well as the future.

There are several other reasons why conservation seems to be frought with bewilderment. First, and foremost perhaps, is that the solution of conservation problems is interdisciplinary. Often, such problems may be resolved only by application of social, economic and scientific considerations. Our primary resource objective is to maintain the quantity and quality of natural resources. The accumulated benefit in human welfare is a social objective. Our scientific technology with regard to effective management of natural resources frequently is far ahead of our application of such knowledge. Because of this we depend upon public aids, legal controls and public education. These are social measures to promote conservation. The scientist may have forgotten long since that he is an important cog in the whole procedure that leads toward more adequate protection of our resource base.

A second source of confusion originates within the ranks of the scientifically trained resource specialists. In this group are the agronomists, foresters, wildlife biologists, hydrologists, geologists, geographers, fisheries biologists, and sanitary engineers. Disagreement over what constitutes the best use of specific resources may be as common among the specialists as among lay groups.

A third roadblock to better conservation understanding is the lack of confidence of the lay citizen in the results of scientific research, perhaps confounded by the scientists' unwillingness to compromise. As Ernest Swift says, "There are substantial numbers of specialists and technicians who alienate a large segment of an otherwise sympathetic public by their narrow motivations and intolerance of a rather broad and varied public interest. If the professional conservationists are leaving the public behind—and this is happening in some fields—it is partially their own fault. Whether they work for private industry or a public agency, their interest must blend with public acceptance if they expect to gain intelligent support." (4)

These introductory remarks are presented in the hope of establishing a degree of understanding as to why conservation presents such a diverse and complex area. My chief concern is to discuss the relation of science to conservation and especially how the various sciences contribute to effective management of our natural resources.

Special Conservation Problem Areas That Need Scientific Solution—

The following question appeared in the American Institute of Biological Sciences Newsletter of March, 1960, "Doesn't the American public deserve better answers than it has been getting in such controversial matters as cranberries vs. aminotriazole, pest controls vs. wildlife, sewage disposal—algae—pollution control, space vehicle ecology, nutrition, population pressure and many, many others?"

"Finally, if the response to this is "Yes," shouldn't the biologists, rather than others, be providing the answers?" (5)

Most of the problems named are conservation problems, yet it is doubtful whether the biologists themselves should commonly classify them as such. Many scientists are working towards solution of problems to improve the resource-use relationship between man and his environment. In such cases, immeasurable dignity may be conferred to conservation, if the scientist identifies his contribution as such.

The two primary problems relating to soil conservation are (1) to control erosion and (2) to maintain the fertility of the soil. Volumes of research have been published on such studies. Yet, soil science is a relatively new field and represents a complex science involving physics, chemistry, biology, ecology, climatology and mathematics.

The late Dr. George D. Scarseth suggested several interesting specific soil conservation problems that needed solutions. (6) These were called hypotheses because they were ideas evoked through observational evidence and could not be substantiated in fact without scientific experimentation. Two of the nine examples given are (1) "Does cornstalk rot develop in very heavy stands of 20,000 stalks or more per acre because of a shortage of carbon dioxide (CO_2)? (2) Since sunlight is one of our most valuable resources, do we waste it in the spring by waiting for the soil to warm before planting?" In the latter, it was suggested that as the soil warms, soil microorganisms release nutrients, especially nitrogen, for crops. So we may not need to wait for the soil to warm, because the nutrients can be supplied in forms ready for the plant to use.

The use of mineral resources presents somewhat different problems because unlike the biological resources, minerals are non-renewable. Duncan J. McGregor, Indiana Geological Survey, in an unpublished paper said, "To be assured of continued and adequate supplies of minerals, we must devote every effort to finding more efficient ways of discovering new mineral deposits, of extracting minerals from deposits currently being developed, of using lower grade ores, of finding new uses for the most abundant minerals, and of finding substitutes for those minerals which are being exhausted, or for those which are difficult to obtain." (7)

There are myriad other resource-use areas that are in need of scientific investigation. The history of any one science is replete with illustrations showing the relation of man's concern in making more intelligent use of the earth's treasures. As has been pointed out, although not all of conservation is science, most of our technological application of wise resource management is the result of the contributions of all of the sciences. The scientist is interested and obligated to furthering human progress and welfare whether in the name of conservation or not.

Some Contributions of the Various Scientific Disciplines to Conservation—

It would be impossible to cover the extensive range of research activity, both past and current, in conservation or closely allied fields. Examples will be used from several of the resource management areas, commonly associated with conservation. Each of these professional fields may be considered combinations or complexes representing several of the more traditional scientific disciplines. Yet, each profession represented is recognized as a scientific technology in its own right.

An interesting resume, although quite superficial, of the development of soil research is related by Dr. George L. Scarseth as follows, "When I started about 1922 to train to become a soil scientist, every PhD candidate stood a good chance of passing his exams if he could set up a hydrogen electrode apparatus and explain pH values in terms of hydrogen ion concentrations or strength of an acid. On his first soils job he was likely to measure the pH values of many things, because he had a new tool. Styles changed; soon soil colloidal behavior dominated the soils literature; then came base exchange and cations absorbed. Someone discovered that phosphorus was not behaving as desired, so phosphate fixation became important; then oxidation—reduction potentials, X-ray patterns, radio-active elements, tracers—all had their day. Yet, there is more to come and the production of technological literature crowds our libraries. I must add that the statisticians also came in, to measure the significance of data." (6) Other excellent chapters follow to show the scientific progress made in understanding the physical, chemical and biological interrelationships of organic matter and the primary fertilizing nutrients—nitrogen, phosphorus and potassium.

Relative to forest management, one might ask, "What is the significance of the science of biology to the role of a forester?" G. S. Allen answers the question in this way, "The forester has many hats, but fundamentally, he is a practicing biologist responsible for growing trees of various species by the millions and utilizing a great variety of climates, topography and soils.—In his role as a biologist, the forester must know his tree species—their requirements for light, nutrients, water and growing space at various stages of their life cycles, their ability to grow in pure or mixed stands, and their reaction to various cultural treatments from establishment to maturity." (8)

As is true with most resources, the primary concern in commercial forestry is to grow the quantity and quality of trees at a cost that will keep the forest industry in business. This calls for biological research, as well as research in marketing economics, and utilization of forest products.

Research in forest biology of special significance in recent years includes (1) studies in tree physiology, (2) analysis of site conditions,

(3) chemical and biological control methods against the ravages of insects and tree diseases, (4) forest ecology, and (5) forest genetics.

Increased knowledge of the physiological characteristics of tree requirements goes hand in hand with developing better site conditions for forest growing species. Forest tree insects and diseases are the greatest enemy of the forest and their effect on growth represents the greatest mortality impact on the forest. A recent biological method of controlling sawfly in Christmas tree plantations is by introduction of a virus destructive to the insect. Research continues on more effective methods of controlling the oak wilt, dutch elm disease, and phloem necrosis. The many dead American elms (Ulmus americana) throughout Indiana are evidence that complete control has not been achieved.

Considering the forest as an ecological unit the forester is by and large fully aware of the disturbing influence of his activities on the forest and its component parts. In writing about "Forest Ecosystems," H. J. Lutz, Yale University, says, "Even before the appearance of man, ecosystems were being upset by changes in the organisms and the environments. Disturbances resulting from activities of the human animal are unique only in their extent and severity. I should like to make it clear at this point that it is not my purpose to personify nature as a kindly, beneficent influence and attribute to her a variety of virtues. I do not concur in the view that to disturb or alter in any way natural forest conditions is to court disaster; in the growing and harvesting of forest crops, disturbance is inevitable and alteration of environment or species composition often necessary. But neither do I find acceptable the view that man can do anything he chooses, that he can safely ignore natural tendencies. Between these two extremes there is a wide opportunity for applying the basic philosophy of working in harmony with natural tendencies." (9)

Forest management as with other renewable resources is based on an understanding of ecology and continuous research in forest ecology is extremely important.

In 1959, the first Central States Forest Improvement Conference was held at Wooster, Ohio. Reports were made on the progress of research in forest genetics from the six research centers in the central states. Although most of the forest genetics research in the central states has been devoted to selection and hybridization, other forest research centers have moved in recent years from empirical to more basic research.

The recent storm of protest over the publication of Rachel Carson's "Silent Spring," in which she condemns the indiscriminate use of pesticides and herbicides has placed the entomologists under a strong conservation spotlight. Not all of their research has been in the area of developing new killing chemicals. Noteworthy of mention here is the biological control method developed by Dr. Edward F. Knipling and his associates in controlling the destructive screw fly which infests livestock in the Southeast. This was accomplished by sterilizing male screw worm flies with radio-active cobalt-60. The sterile males, mating with the females in the native population, nullified their reproductive capacity and the natural population was eliminated. Now Texas has developed a fly plant which produces 75 million sterile flies a week for use in the Southwest.

Fisheries management and wildlife management are recognized professions that have long been associated with conservation. Certain established principles of wildlife management illustrate the importance of scientific research in providing suitable habitat to maintain our wildlife resources.

The wildlife biologist measures the quality of range of an animal species on the basis of what a given area of land will support. This is called "carrying capacity." The bobwhite quail, for example, must find a combination of crop land, pasture, and forest or brush land within easy daily reach to supply its biological needs since quail are birds of low cruising radius. That means their daily flight seldom extends beyond one-fourth to one-third of a mile. Their annual flight does not exceed three miles from home base. The home range, therefore, must provide all its needs at all seasons of the year. An animal population cannot increase in numbers beyond the limits set by the least abundant necessary factor. Thus, if winter conditions are most critical to supply the needs of a species, these factors set a limit on the carrying capacity.

Another principle related to carrying capacity is explained by Allen as follows: "Carrying capacity may have its most important effect by influencing productivity of breeding stocks of various sizes. In a given area, as the number of breeders increases, the production and survival of their offspring is proportionately reduced—a relationship sometimes referred to as *inversity.* This is not true as long as the population is far below "normal" stocking, but after a reasonable build-up it seems to hold." (10)

An example of this was cited from the state of Iowa where a severe winter of 1936-37 killed a large part of the quail population. Records showed that on this area of several thousand acres, the breeding stock in the spring of 1937 was about one bird to 86 acres. The spring nesting conditions were favorable and by fall the population increased by 457 percent.

The surviving breeding stock the following spring of 1938 was up to one bird per 16 acres, but even though favorable weather conditions prevailed again, the season's increase dropped to 183 percent.

Again, a mild winter favored the survival of a large breeding stock and by May of 1939 there was one quail for every six acres which is considered a heavy breeding population. Yet, the birds were able to accumulate only an 84 percent build-up by fall.

As larger breeding stocks produced more young, it seemed that the environmental limitations reduced the proportion that could survive.

Another meaningful principle involved in the mechanics of populations is referred to as "compensation." This refers most significantly to the interrelationship of various mortality factors. It means that when man fails to take a hunting harvest, nature does it for us. Populations may be reduced by predation, disease, starvation, and other decimating agencies. In other words, when the hunter takes a big crop of game in the fall, he thins out the population and all other mortality rates decline. Hunting has substituted, or compensated, for losses that otherwise would have taken a larger share of the population during the winter. We do not carry a surplus over from one year to another.

The examples of results of research in the professional fields of soil science, forestry, entomology and wildlife are cited to show that the best use and management of our natural resources is dependent in large measure upon scientific processes. Although not all conservation problems are solved by the physical and biological sciences, it is believed that the scientists working in these research areas should shoulder greater responsibility in making their voices heard in the realm of politics and social organizations.

Ecology and Conservation—

Many of the contributions of ecology to natural resource-use have been mentioned. More significantly, attention should be called to the numerous conservation problems that are man-created and, therefore, should be classified as a part of human ecology. The population explosion, pollution of streams and lakes, our spreading "urban" developments, increasing pressure on land and water areas for recreation, drift of industrial smog over our cities, the safe disposal of atomic wastes, and perhaps not least, the maintenance of the genetic quality of man.

The United States is rapidly changing from an agrarian-centered to a city-centered ecosystem. In the past, conservation has been considered largely a farm problem with primary attention given to reducing erosion, maintaining soil fertility and the management of forests, fish and wildlife. In our race for domination of space, it seems rather paradoxical to spend billions to send a man to the moon while we fail to solve our space problem on earth. It is my belief that conservation has become a far greater city problem than a farm problem. Unfortunately, the average city dweller is placidly unaware of his plight while he tries to find a suitable place to fish in waters he has not yet polluted, and wonders why it takes so long to drive home from the office on traffic-clogged streets resulting from laxity in community zoning and planning.

Dr. Allen (10) raises the question whether man, the creature, will overrun his environment and convert it into a biological slum. Allen continues by saying, "There is ample evidence that a reasonable natural world is the only sanitary environment for a human being or any animal. The nobility of man will be a vain and farcical idea if the earth is to be parceled out until every individual is competing with his equals for a meager share of pure air, clear water, green grass, and cool woodland. When we come to live by bread alone, we will have lost the something that makes us more than creatures." Pearson & Harper (11) say, "The food productivity of the earth could perhaps support three billion persons on the Asiatic standard of living. This is a considerably greater number than the present estimated world population of 2.1 billions (1945). But at the United States standard of living, the present food productivity of the globe could support fewer than a billion persons.

The American community has evolved toward a standard of living far beyond that of most nations. Science, technology and an abundance of resources have made it possible. Our agricultural scientists indicate that this nation can support an increasing number of people. Do we wish to live by bread alone? Science may find more effective means to solve the afore-mentioned conservation problems but some aspects of our space requirements are non-renewable as, for example, wilderness, unique landscape features in national parks, and habitat for specific wildlife species.

If man is to maintain his heritage, there must be a greater understanding of the human ecosystem. While scientists have worked independently toward solution of resource-use problems there is a great need for better communications. Our technological progress has outraced the evolution of our social, economic, and political processes. This is a basic cause for many of the world's current problems.

The plight of the human race has been stated in a frightening manner by a former physicist at Oak Ridge, Dr. J. H. Rush, who said, "Just as the evolution of enzymes and later of photosynthesis and oxygen metabolism revolutionized the power of living organisms over the environment, so the technology created by intellect is revolutionizing it again. With his machines and processes, man advances his competitive position more in a century than he could in 1,000,000 years of biological evolution. . . ."

"Man, the product of 2,000,000 years of patient protoplasmic experiment, has been on earth only a moment of geological time. Yet he already holds the power to destroy all life, even the planet. Outwardly he shows little awareness of his responsibility or his peril; but the fear is seeping into his bones." (12)

The ramifications of human ecology are complex indeed, compounded by man's intellectual capacity to alter the environment. No one wishes to return to a stone age civilization nor to the life of the early pioneer just to preserve the natural habitat. But there is a scientific, social and economic consciousness that needs to accept the view that we cannot safely ignore the consequences of wasteful exploitation of our land, waters, wildlife, minerals, as well as human resources. This presents a formidable challenge to every phase of human endeavor.

Literature Cited

1. PINCHOT, GIFFORD. 1947. Breaking New Ground. Harcourt, Brace and Company. p. 236.
2. WIRTH, CONRAD L. 1953. Conservation Quotes. National Park Service. pp. 2-6.
3. LIEBER, RICHARD. 1942. America's Natural Wealth. Harper and Bros. p. 212.
4. SWIFT, ERNEST. 1961. The Meaning of Conservation Education. Conservation News. The National Wildlife Federation. 26:11 pp. 4-7.
5. Newsletter. 1960. American Institute of Biological Sciences. 1:2 p. 1.
6. SCARSETH, GEORGE D. 1962. Man and His Earth. Iowa State University Press. pp. 87-90, 81-82.
7. McGREGOR, DUNCAN J. 1962. Mineral Resources and Human Progress. Unpublished paper. p. 7.

8. ALLEN, G. S. 1963. The Role of Biology in the Forest Industry. American Institute of Biological Sciences Bulletin. **13**:4 p. 32.

9. LUTZ, H. J. 1962. Forest Ecosystems: Their Maintenance, Amelioration and Deterioration. Journal of Forestry. **61**:8 p. 566.

10. ALLEN, DURWARD L. 1962. Our Wildlife Legacy. 2nd Edition. Funk and Wagnalls Company. pp. 52, 337-38.

11. PEARSON, FRANK A., and FLOYD A. HARPER. 1945. The World's Hunger. Cornell University Press. p. 69.

12. RUSH, J. H. 1958. The Next 10,000 Years. The Saturday Review. **41**:4 pp. 11-12.