# A HISTORY OF SCIENCE IN THE NATIONAL PARK SERVICE

Henry E. McCutchen, Ph.D.
National Park Service
CPSU/Northern Arizona University
August 19, 1992

DRAFT MANUSCRIPT
NOT FOR PUBLICATION

In 1916 Congress passed the act creating the National Park Service (NPS) "....which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations".[1] This mandate charges the agency with two seemingly conflicting missions, that is, providing for preservation but also use (without impairment) of the lands under its administration. This commission is one of the most challenging, yet difficult, relating to land use in the United States today. For the service to carry out these responsibilities there is an implicit need to acquire knowledge of the parks, their resources, their uses and their problems.

Although managers of the parks can glean a great amount of information from general observation and sources, many problems, particularly ecological ones, are so subtle and complex that they require painstaking and systematic observation by highly trained scientists. The resulting information, collected and tested by the scientific method, will be of highest quality and reliability for management decisions, for public information, for scientific use and in courts of law. The resources of the National Parks and their human advocates deserve no less.

The terminology of science and management often varies among disciplines and organizations and is confusing, not only to the lay public but even among the professionals. Within the National Park Service the term "natural resources management" has only recently come into vogue although it has been around for many years. A useful definition of it is "activity directed toward achieving or maintaining a given condition of the biological and physical resources in accordance with the conservation plan for the area"[2]. Scientific research plays a support role for park management functions including natural resources management, interpretation (education), and planning by supplying reliable information.

The terms research and science are often used synonymously within the National Park Service (and will be used so in this article), but there are subtle differences. One definition of research is "studious inquiry aimed at discovery and interpretation of facts". Research may be conducted solely at a library but it can also be conducted in laboratories, out of doors or at a combination of these. Research has been conducted in the Service in fields as diverse as history and archeology as well as in the natural sciences. More specifically, however, science is knowledge tested through the application of the scientific method which includes the formulation of a problem, collection of data through research, and the rigorous testing of hypotheses to ascertain the facts. Within the National Park Service the disciplines considered to be science are those in the

natural (Botanical, Zoological, etc.), physical (Geological, Hydrological, Meteorological etc.) and social sciences.

This review shows that science has undergone severe booms and busts throughout National Park Service history. From the late 1800s to the 1920s the parks' scientific information needs were provided primarily by individuals and organizations outside the agency. Beginning in the late 1920s though the 1930s, an official science program melded with wildlife management and planning developed within the Service and underwent a major expansion in funding and personnel. Later, from a few years prior to World War II and into the 1960s, a period of nearly a quarter of a century, the program became moribund from the attendant personnel and funding cuts and lack of support. In the early 1960s the program was resurrected and has shown gradual expansion, with many reorganizations to date. It remains, however, relatively small in relation to the overall NPS personnel numbers and budget and is still struggling for an identity.

As the National Park Service has matured over time new scientific and technological information played important roles in changing park programs and management philosophy. Among these has been the major shift in park management philosophy from basic protection and single problem management to a more modern, holistic view of park ecosystem management. Even today the philosophy of managing natural areas is undergoing re-evaluation.

## SCIENCE IN THE EARLY YEARS (1872-1929)

Both the NPS science program and interpretive (education) program have intermingled roots that predate the establishment of the Service. Scientific research in the early days was, for the most part, the gathering and dissemination of basic descriptive data. As such science served as the handmaiden for park interpretation. Yellowstone, the first National Park, was established in 1872. The U.S. Army was assigned to protect the parks in 1886, and soldiers in Yellowstone stationed at geyser areas to protect them were soon giving "cone talks" in response to incessant visitor questioning.[3] As park interpretive needs increased efforts were made to make them as factual as possible through the use of scientific information. One early example of the use of scientific information for park interpretation is the publication of "The Yosemite Guide-Book" in 1869 by California State Geologist J. D. Whitney.[4] In 1912 Department of the Interior scientists from the Geological Survey were writing pamphlets on the natural history of the parks for tourists.[5]

Literature on the history of science in the National Park Service is scarce and only a few individuals have documented it. Any review of the subject must, by necessity, draw heavily upon the work of Lowell Sumner, a retired NPS biologist, who wrote about it, covering the early years up to the mid-1960s. Sumner[6] traces the beginnings of NPS ecological understanding and

research program to the insight and leadership of Joseph Grinnell. In the 1920s and 1930s Grinnell, a vertebrate ecologist at the University of California, taught the concepts of ecological interdependence and that natural ecological processes should not be interfered with in the National Parks. He co-authored books on Yosemite National Park and Lassen National Park[7] elaborating upon these concepts. His teachings directly influenced a number of students who later had leadership positions in research and management in the National Park Service. These included Dr. Harold C. Bryant (the first chief of the Branch of Research and Education), George M. Wright (first chief of the Wildlife division), Ben H. Thompson (a researcher who later became an assistant director of the NPS), Joseph S. Dixon and Lowell Sumner (two well known NPS field researchers) as well as others.[8]

In 1920 Stephen Mather, first Director of the National Park Service, took steps to formalize the connections between science and interpretation. The Director enlisted scientists and educators Dr. Harold C. Bryant of the University of California and Dr. Lloyd H. Miller of the University of Southern California to develop a nature program developed from scientific databases in Yosemite National Park. They carried out campfire programs, guided walks and developed nature trails. Concurrently, Ansel F. Hall was appointed as the first Yosemite Park Naturalist. He was an inveterate collector and shared his interest with park visitors by starting a museum in the park. He constructed

showcases and collected and mounted the flora, fauna, geological specimens and cultural artifacts for the exhibits.[9] During the same year at Yellowstone National Park Milton Skinner, a long time seasonal naturalist in the area, developed a museum.[10] These collections and museums were the precursors of the Service's scientific collections program.

The link between university scientists and the NPS interpretive program was very strong and beneficial for the agency. In 1925 when Hall became Chief Naturalist of the Service he maintained offices at the University of California at Berkeley. In Yosemite Dr. Bryant established the Yosemite School of Field Natural History in 1925 to train naturalists for the expanding NPS needs.[11]

The other needs of the growing interpretive program were a centralized office and more scientific information to support field naturalists. In 1930, in response to the recommendations of an advisory Committee on Educational Problems in National Parks a branch of Research and Education was established with Dr. Bryant as its head. Offices continued to be maintained at the University of California at Berkeley.

## THE GEORGE WRIGHT ERA (1929-1936)

In the formative years of the NPS, its first two Directors, Stephen Mather and Horace Albright, placed emphasis primarily upon developing the agency and a constituency for it and

expanding the National Park System. Policies tended toward the general rather than the specific. Other areas of concern for them included keeping the agency from being absorbed by the U. S. Forest Service; obtaining the necessary political, legal, and funding base; increasing park staff; and eliminating conspicuous adverse uses in the parks such as lumbering, livestock grazing, hunting, trapping, farming, water development projects, irrigation, and mining. The directors also recognized the need to create a national public interest in the parks. They accomplished this by providing improved access and facilities and educational programs for park visitors, working with concessionaires to publicize the parks and establishing the National Parks Association.

As policies to conserve the resources yet permit human use without impairment of the land were implemented in the National Parks primal concepts of this new form of natural resources management began to emerge. One of the first management priorities was to protect the parks from adverse uses. This was carried out in the parks by park rangers who patrolled the areas and vigorously enforced the laws and regulations. The efforts of the rangers were highly effective and have continued to be to the present time. Protection is a major and necessary component of park management; however, in the formative years of national parks protection, in some cases, it was carried out to the extreme. For example, many parks controlled (killed) large predators such as the wolf, mountain lion and coyote in order to

"protect" ungulate (hoofed) species such as the deer, elk and bighorn sheep. Also forests were "protected" from natural processes such as fire, insects and disease. These programs had adverse impacts on other fauna and flora and eventually came under the hard scrutiny of research.

By the late 1920s there was a need for the agency to develop an overview in specific management problem areas. Further, there was a need to systematically assess the extent of problems and develop policies and programs for the correction and "fine tuning" of management actions. Wildlife management (and the supporting ecological research) was one such area, and a young man named George Wright elected to address this issue.

In the early 1920s Wright was a student at the University of California at Berkeley. He majored in forestry but had a minor in vertebrate zoology under Dr. Joseph Grinnell.[12] In 1926 Wright worked for Dr. Grinnell as a field assistant at Mt. McKinley National Park, Alaska, and in 1927 he received a permanent position with the Service as the assistant park naturalist at Yosemite NP.

Through the influence and tutelage of Dr. Carl P. Russell, Yosemite's chief naturalist, and Dr. Grinnell, Wright became keenly aware of the numerous ecological ills and human impacts that had occurred and were occurring at Yosemite. At that time, although National Park status and ranger patrols had given Yosemite's fauna some greatly needed protection, there were still many problems.

Trapping and hunting outside the park boundary was reducing wildlife populations, particularly the large predators inside Yosemite. Much of the critical winter range for the deer was either outside the park or on privately owned land inside the park. The cutting of forests occurred right up to the park boundary, and local ranchers were applying political pressure to allow grazing for their livestock in the park. The grizzly bear was extinct, and mountain lions and other predator populations were low. Lacking the natural check of predators, the deer population in the park had burgeoned to high numbers. They were reducing the populations of shrubs and wild flowers. The black bears had become such a nuisance raiding garbage cans and visitor property for food that a feeding station had been established several miles away from human use areas to draw them away.[13] Wright concluded that more attention and effort needed to be directed toward the administration and management of wildlife, not only at Yosemite but throughout the Service as a whole.

In 1929 Wright approached Director Albright and asked for his advice and support on a project to survey faunal conditions in all Parks. Wright, who was independently wealthy, offered to finance the program out of his own pocket. Albright accepted Wright's offer and gave the project his blessing. Realizing that additional political support was highly important to the project, Wright also obtained the approval of Dr. Harold C. Bryant, Assistant Director of the NPS, and Ansel Hall, Chief Naturalist

of the Service, as well as that of Drs. Carl Russell and Joseph Grinnell.[14]

Within the year Wright had assembled a team consisting of himself and two other field biologists, Joseph Dixon and Ben Thompson. He also had hired a secretary, leased an office in Berkeley and obtained the necessary vehicles, office and field equipment for the survey.

There were a number of objectives to be accomplished by the survey. First, particular attention was to be focused upon the development of a scientifically based wildlife policy for the NPS. Second, recognizing that the effectiveness of the program also was dependent upon its acceptance by field personnel, they emphasized that the project was to provide assistance to the park superintendents confronted with urgent animal problems. Finally, they envisioned a major report which would systematically identify the faunal problems in the parks and provide a plan to correct them.

The survey procedure included four steps:

1. Reconstruct the faunal situation as it existed in the natural environment before disturbance by European man.
2. Study the land use history of the area up to the present time.
3. Survey the existing situation of the various species including their systematics, life history and ecology.
4. Develop a plan to restore the faunal situation to that approximating step 1.

The survey started in 1929. Within three years hundreds of man-hours of effort and thousands of miles of travel had been devoted to criss-crossing the country and visiting the parks.

In 1931, the group completed the survey and began to write their report.[15] The Service, recognizing the potential of the program, began to gradually integrate it into park operations. Increasing levels of public funds were provided, and the office was moved to the Berkeley campus. In 1932, Wright's group was formally made the Wildlife Division in Bryant's Branch of Research and Education. The function of the Wildlife Division was to provide for planning, review and assistance in ecological research and management of biological resources.[16] Thus, during this period natural resources management, particularly wildlife management, and ecological research were inseparable with field personnel carrying out dual roles in these functions. In that year also the first report was published, entitled: Fauna of the National Parks of the United States. A preliminary survey of faunal relations in National Parks. Volume 1 authored by Wright and his co-workers.

Fauna No. 1 was a landmark document in establishing wildlife management and natural science research policy for the NPS. It identified the many ecological problems persisting in the parks and suggested sound management solutions. It recommended techniques to restore reduced plant and animal populations as well as restore those that had become extinct in an area. It identified the indirect impacts on wildlife habitat from ongoing

and historic livestock grazing, agriculture and lumbering and recommended methods for habitat restoration. It noted problems relating to abnormally high wildlife populations due to removal of predators and other natural controls. It also recognized the problems related to the parks not being established as independent biological units and recommended boundary changes and land purchases to correct that situation.

Of great importance was the recognition that protection of the parks was not enough and that active management was also necessary to rectify many biological problems. Fauna No. 1 not only addressed wildlife problems but was holistic in its approach, noting the need for the "perpetuation of natural conditions".[17] Wright's work also emphasized the importance of research as a tool to support resources management decisions in the NPS. The final pages of the book listed 20 items that established a wildlife policy for the Service.

After their publication in Fauna No. 1 the policies were officially adopted by the Service. Field biologists were issued copies of Fauna No. 1, and it became the "working bible" for them and other NPS personnel until after World War II when it went out of print and the program was de-emphasized.[18]

In 1933, scientist and educator Aldo Leopold published his pioneering book Game Management. This volume provided the first major synthesis of the science and technology related to the emerging field of wildlife management. Leopold[19] independently supported Wright's findings noting the differences between active

management and passive conservation. He wrote that management based on scientifically sound ecological principles was not only desirable but necessary for husbandry of the land and its physical and biological resources. Leopold supported the concept of long-term, in-depth research, noting that wildlife cannot be understood without understanding the ecosystems of which they are a part. This book had a profound effect and influence upon the professionals in the field including Wright and his NPS colleagues[20].

The Director of the National Park Service, Horace Albright, was proud of the progress of the agency and Wright's Wildlife Division in research. In 1933 he published an article on research in the National Parks listing the accomplishments.[21]

On another front, the concept of research reserves in the National Parks was developed in 1933. These were areas within the parks which were outstanding in their primeval ecological character. They were to be utilized primarily for research and to be protected from any human impact. By 1940 twenty-eight of the reserves had been established in NPS areas.[22] The program was later expanded to include about fifty-six sites which were later renamed Research Natural Areas.[23]

President Franklin D. Roosevelt and his New Deal programs began to combat the effects of the Depression in 1933. A variety of emergency work relief programs were created which impacted the Service. The most significant of these was the Civilian Conservation Corps (CCC). This program was created to provide

work and job training in new skills for many unemployed young men. CCC camps were established in many parks in the 1930s. Conservation groups were concerned that the massive development programs of the CCC would adversely impact the parks' natural resources. However, Wright was quick to make use of the CCC funds to increase the number of Wildlife Technicians in the Wildlife Division. Many were headquartered in the parks and were responsible for reviewing the proposed management and development projects that involved wildlife or wildlife habitat.[24]

The efforts of the Wildlife Division during the CCC period were quite effective in preventing adverse impacts in the parks but the results were not highly visible. Unfortunately in some quarters within the NPS animosity began to develop and members of the Wildlife Division were looked upon as obstructionist and overzealous.[25] Smathers,[26] an NPS scientist, notes however, that with this program the Service was nearly forty years ahead of the National Environmental Policy Act of 1969, which requires the preparation of Environmental Impact Statements and Assessments on federally funded projects. During the CCC period in the NPS members of the Wildlife Division also assisted the New Deal agency in the development of many projects that were for wildlife habitat management and improvement, plant improvement and wildlife research. This was in addition to maintaining their own productivity in ecological research in the parks.

In 1935 Wright, in conjunction with Ben H. Thompson, published Fauna No. 2 Wildlife Management in the National Parks.

It updated the developments in wildlife management which had occurred in the National Parks since Fauna No. 1. The publications of Wright and his colleagues had a major impact upon some NPS resources management policies but not all of them. Mr. Wright was never able to get NPS management to accept the ecological role of native insects killing trees nor was he able to sell the concept of maintaining fire in forests which were dependent upon natural fires for regeneration and maintenance.[27]

Also during 1935 the Washington Office Branch of Research and Education was reorganized. The Wildlife Division was transferred from Berkeley to the Washington D.C. office.[28] Wright remained chief of the Division and Thompson served as the Assistant Chief. Dixon stayed at Berkeley as a field naturalist. Other Divisions within the Branch included the Naturalist, Park Relations and Education Divisions. The move enabled the Wildlife Division to better oversee the developing CCC programs at the national level as well as to maintain the general wildlife management and biological research programs. Because of the CCC operations the Wildlife Division also increased in the number of personnel so that by 1936 there were 27 (4 regular, 23 CCC) biologists on the staff nationwide.[29]

The year 1936 was marked by tragedy for the Wildlife Division and was the high-water mark for the wildlife and science program of the NPS for many years to come. On February 25, 1936, George Wright and Yellowstone Superintendent Roger Toll were automobiling in New Mexico. They were members of an

International Commission evaluating potential park and reserve lands along the U.S.-Mexican border. Near Deming, New Mexico, an oncoming car blew a tire and collided head-on with their vehicle, killing both Toll and Wright. The latter was just 31 years old at the time of his death.[30]

The legacy that Wright left for the NPS has been eloquently expressed by Sumner:[31]

"George Wright was so far in the forefront of his time that his publications on wildlife management and the ecological protection of parks, though long out of print, still sound modern....in retrospect it still seems almost unbelievable that such a young newcomer was able, in so short a period of time to introduce a set of new management concepts into an old-line Federal organization, and recruit from all over the country a team of park-oriented biologists, most of them not long out of the graduate schools, to help carry out the new ideas".

## A PERIOD OF DECLINE AND CONSOLIDATION (1937-1963)

After Wright's death, Victor Cahalane became Chief of the Service's Wildlife Division. Cahalane had impressive credentials, having worked as a field biologist at Wind Cave before transferring to Washington D. C. to work as Wright's Assistant Chief, and a contemporary stated that he was "the best qualified biologist in the Service",[32] for the position. For a period of time Cahalane was able to maintain the momentum of the

programs of the Wildlife Division. However within the NPS there was an increasing opinion among administrators that "biologists were impractical, were unaware that parks were for people, and were a hindrance to large scale plans for park development".[33]

One battle which the Wildlife Division had with management was over predator control in Yellowstone National Park. Coyotes, as well as other predators, had been controlled sporadically in Yellowstone for many years in an effort to protect ungulates such as the bighorn, antelope, elk and mule deer. In 1937, NPS biologist Adolph Murie[34] was assigned to the park for a two-year period to investigate the impacts of the coyote upon ungulate species.[35] Murie found that coyotes fed heavily upon mice, pocket gophers and carrion and that although they did occasionally kill deer and elk, they had no appreciable negative impacts on the large populations of ungulates in the park. His report[36] provided support for an agency policy on protection of predators. According to a colleague, Lowell Sumner, Murie's findings were not favored among some Service managers and especially not within the Department of the Interior where predator control was popular.[37]

Prior to 1937, the Director supervised the field areas without intermediate bureaucracy. The Service had expanded so much that this structure was no longer workable and it became necessary to divide the country among four regions in 1937 (Richmond, Va.; Omaha, Neb.; Santa Fe, N.M.; and San Francisco, Ca.) with Regional Directors supervising the field areas. A

number of biologists and geologists were assigned to these regions.

By 1939, the Wildlife Division had shown significant declines in personnel and funding. There were only 9 personnel in the Division (4 regular, 5 CCC funded). Sumner[38] attributes this, in part, to administrative attacks, noting that no one among the biologist ranks had the political clout or the friendly persuasiveness that had been exhibited by George Wright. Another factor was that World War II was approaching and changing national priorities reduced the need for employment programs.[39]

Later in 1939 the Department of the Interior was reorganized by President Roosevelt. All of the biologists within the Wildlife Division were transferred out of the NPS and into the Bureau of Biological Survey (later to become the Fish and Wildlife Service), a sister agency within the Department, where they became part of a new Office of National Park Wildlife. The Division was allowed to maintain its functions and support of NPS projects but Congress had become so hostile to the concept of research within the federal government that the word was even dropped from the title of the Division of Research and Education within the NPS.[40] The comparable staff and program in geology was also eliminated in the NPS during this period. The result of the reorganization was the near elimination of scientific research in the parks with only a handful of scientists having active projects in them.

The entrance of the United States into World War II in 1941 caused vast changes and reorganizations in the federal government. By this time the Biological Survey had been renamed the Fish and Wildlife Service. In the early 1940s a few of the Divisions biologists were transferred back into the National Park Service but with the termination of the CCC and its funding most were assigned other duties within the financially strapped agency. During the war only three biologists continued to work on their NPS projects, Victor Cahalane, Adolph Murie and Joseph Dixon.[41] In 1944, Fauna No. 5, The Wolves of Mt. McKinley, by Adolph Murie was published. Murie had been assigned to this project in 1939 in response to sportsman groups pressuring Congress to control wolves in the park to protect wildlife. Murie found that although wolves did kill large mammals they preyed primarily upon the old, the young, the sick and the diseased which actually enhanced ungulate population vigor and health. Thus, again, Murie's findings supported the policy of protection of predators within the National Parks. Sumner[42] notes that Murie's monograph on wolves, as well as the one on coyotes, became classic works in the field of wildlife biology and were required reading in many college classes. Fauna No. 5 is looked back upon as marking the end of any effective science program in the NPS. It would be seventeen years before another Fauna issue would be published. It would be twenty-five years before the science program would be restored to prewar staffing.[43]

Also in 1944 Cahalane was transferred back into the NPS. He was the sole biologist in the Washington D.C. office. He became the chief of the Biology Division in the branch of Natural History. This branch had descended from the old branch of Research and Education. Other divisions in the Branch included the Museum and Naturalist Divisions.

Cahalane continued to push to restore the biology division to prewar levels. In 1945 the NPS issued a report "Research in the National Park System and its Relation to Private Research and the Work of Research Foundations". The report recommended a comprehensive research program and an adequate staff in the NPS to support interpretation and management. The report listed seventy-seven biological problems needing research in the parks. In addition to natural history, archeological and historical research were also supported. Apparently, nothing much came of this effort.[44]

Even with low staff numbers the biologists in the NPS were productive. Cahalane in particular was able to maintain a steady flow of publications and by this time had published nearly sixty articles and books relating to national parks and wildlife. In 1947 he published his 682 page Mammals of North America, one of the most authoritative works of its kind at that time.[45] Also in 1947 the NPS submitted a report on policy and research administration prepared for the President's Scientific Research Board. With its submission, Director Newton Drury admitted that the status of the agency research program was not "altogether

satisfactory".[46] By this time Cahalane had an assistant, and there were eight field scientists in biology and geology.[47]

Soon after the Second World War the naturalists' ranks were restored to prewar strength. The naturalists filled the vacuum created by the lack of full-time scientists by conducting their own research when they could find the time. A number of naturalists including Edwin McKee (geology) of Grand Canyon, Frank Brockman (plant ecology, herpetology ) of Mt. Ranier, Arthur Stupka (vertebrate ecology) of the Great Smokies and Milton Skinner (vertebrate ecology) of Yellowstone made significant contributions to their field with their work and publications.[48]

Following 1945 the naturalists continued to maintain some research effort but the increasing demands for interpretation created by increasing visitor use reduced research time to a minimum. However, the interpreters were responsible for issuing research permits, maintaining the park libraries (an important repository for research manuscripts) and curating the scientific collections. Traditionally, at a park, the museum program has consisted of two components: the public exhibits and the closely managed collections of the flora, fauna and historical and archeological artifacts. Nearly all the parks have these collections. They require careful preparation and painstaking documentation to be scientifically valid. This program has continued to the present time. It has been highly important to

the NPS interpretive and science programs and has been important to the scientific community as well.

The science program for the Service continued to be de-emphasized during the late 1940s, and there was a general attitude by the Congress and the agency that cooperative agreements with other agencies such as the Fish and Wildlife Service, Forest Service and Geological Survey would provide any scientific information the NPS needed.[49]

After the war visitation to the parks exploded, showing record levels yearly. By 1948 visitation to the parks was over 29 million, nearly 5 times what is was in 1943. The park facilities which had been allowed to deteriorate during the war due to shortages of funds and personnel proved to be inadequate for visitors and park personnel alike. Because of the overcrowding, lack of protection and inadequate staffing in the parks, the Service came under increasing criticism by the public, the news media and conservationists.

In the mid 1950s, Conrad Wirth, the Director of the National Park Service proposed a workable solution. He recommended the creation of a ten-year, multimillion dollar development program to bring the parks up to standard to meet public demand. With Congress' support and President Eisenhower's approval the program was initiated in 1956. Titled "Mission 66" it was targeted for completion by 1966. This massive program led to the construction of thousands of miles of new and improved roads and trails, the development of dozens of new maintenance facilities, 2000 new

residences for park employees and 130 new visitor centers and museums.[50] Unfortunately, because Mission 66 was construction intensive and, unlike the CCC program, had no positive biological program to mitigate or reduce impacts on the parks, Cahalane resigned his position in frustration in 1955.[51]

Gordon Fredine, a long time Service employee, became the new Chief of the Biology Division. He maintained the pressure to increase the biological program to support the increasing threats and biological problems mounting in the parks. In 1956 a conference of NPS biologists was held in Washington, D.C. It was the first since 1939. The group submitted a list of suggestions to the NPS for strengthening the NPS biologist program. In 1957 Fredine was successful in obtaining a new aquatic biologist position for the Washington Office. A previous position had existed from 1934 to 1940. Orthello L. Wallis, who had gained recognition for his outstanding fisheries management studies at Yosemite, was chosen for the position.[52] In 1958, another break with tradition occurred when Fredine's program was reorganized into two administratively separate activities, research and management. Research remained the responsibility of the Branch of Natural History, with Fredine in charge, within the Division of Interpretation. Resources management responsibilities were transferred to a new Branch of Resource Protection in the Division of Ranger Activities.[53]

The year 1958 marked the change of the total fire suppression policy of the NPS. Experiments in prescribed (human

ignited and controlled) burning were initiated in Everglades National Park during the year. These were due to the efforts of Dr. William Robertson who began to conduct research upon fire ecology in the early 1950s and found that fire was essential in maintaining the park's vegetation.[54]

During this year the first funds, $28,000, were formally allocated by the agency for natural history research in the parks.[55] Although these funds were pitifully small, they had a pump-priming effect that increased their overall importance many times over because universities and research institutions were willing to contribute additional resources once NPS funds were made available. Furthermore, these funds were supplemented with project research funds which traditionally were made available in the Service through miscellaneous year-end money, small allotments from park budgets and private donations. Allowing for a time lag to get the projects organized, by 1962 the funding had provided for several dozen reports on critical ecological problems in the NPS areas.[56]

In many National Parks the superintendents relied heavily upon the funding and research of outside agencies. In Yellowstone during 1959, Superintendent Lon Garrison welcomed the research skills and financial support of Drs. John and Frank Craighead of the University of Montana and entered into a cooperative agreement with them. These scientists, masters at grantsmanship, had obtained grants from the National Science Foundation, National Geographic Society, The Atomic Energy

Commission, Office of Naval Research and other institutions for research in the park. The Yellowstone Park Company provided housing and utilities for the Craighead team. The U.S. Fish and Wildlife Service also provided for costs as Dr. John Craighead was a scientist with that agency. With about $50,000 to $60,000 per year in funds, the Craigheads organized the largest research team within any NPS area and began conducting studies on a variety of species in the Yellowstone Ecosystem including grizzlies, elk, black bears and raptors.[57] In 1961 Fauna No. 6: The Bighorn of Death Valley by Ralph and Florence Welles was published. This publication broke the long hiatus which the Fauna Series had suffered since 1944.

## A NEW ERA OF SCIENTIFIC AND ECOLOGICAL AWARENESS (1963-1971)

The record by this time[58] shows that from the beginning of World War II and through the 1950s the Service had done little in the way of bringing its science program (biological and geophysical) to pre-war levels in spite of increasing ecological problems in the parks. In 1961, the ground swell of public concern over the minimal research and management response to critical resource problems in the parks began to make a difference. The new Secretary of the Interior, Stuart Udall, had a record of concern for environmental issues. In 1961 his Advisory Board on National Parks, Historic Sites, Buildings and Monuments, after a careful review, recommended an expanded Agency

research program. This group noted that historical and archeological research within the NPS had shown its value but that research in the multifaceted field of natural history had remained inadequate. Secretary Udall was receptive to this recommendation. In addition, his office and the NPS had become embroiled in a national public controversy over how the elk in Yellowstone should be managed. The northern Yellowstone elk population had increased to such high numbers that in order to reduce their impact on park resources, over 4,000 were shot by park rangers in the early 1960s, creating an enormous public outcry.[59]

Secretary Udall, looking for support, decided to seek the best and most objective evaluations that he could get. He requested evaluations of the NPS programs and policy in three major areas, wildlife management, research and the social-political-ecological problems of the national parks.

For wildlife management Udall obtained an advisory board with prestigious members from the scientific, academic and government communities who were world renowned authorities in the areas of wildlife management, ecology and land use. This board was chaired by Dr. A. Starker Leopold. Dr. Leopold, an authority on wildlife management and vertebrate ecology, was the son of Aldo Leopold.

The board's report "Wildlife Management in the National Parks" was issued in 1963. It almost immediately became one of the most widely read and quoted conservation documents pertaining

to national parks. The report had an enormous impact upon NPS policy. Of major importance was the fact that the Leopold Committee found that they could not just address the wildlife problems in the parks without first addressing the overall goal of National Park management. With this in mind, the report stated, "As a primary goal, we would recommend that the biotic associations with each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white men. A national park should represent a vignette of primitive America".[60]

The Leopold Report[61] also made a number of important observations and conclusions such as: defining what national park natural resources management is; recognizing that few parks are large enough to be self-regulating ecological units and are for the most part ecological islands; noting that stable communities and those undergoing natural ecological succession need little or no active management; noting that communities modified by man will need active management to restore them; and noting that animal populations out of balance with their habitat and threatening the environment will require population control. The committee questioned the practice of the NPS applying insecticide to control forest insects in the parks. It also noted that fire plays an important ecological role, indirectly questioning the efforts of the NPS to suppress all fires in the parks.

The report also had two recommendations relating to research: management practices in the parks must be based upon

scientific research, and both research and management must be undertaken only by qualified personnel.[62] Sumner[63] noted that the Leopold Report essentially reached the same conclusions as the long-forgotten Fauna No. 1 of Wright and his colleagues in 1933. This time, however, ecology was a known and accepted science, and an era of environmental awareness had begun in the United States.

The second evaluation for research in the NPS was conducted by the National Academy of Sciences. The credentials of this committee were as distinguished as those of the Leopold Committee. The committee on research was chaired by Dr. William J. Robbins. The report[64] reviewed the history of the Service science program, interviewed NPS scientists, and reviewed the current research needs and how they were met by the agency. The report had highly critical comments about the NPS science program as it was being handled at the agency level but tempered its criticism with a show of respect for the dedication and competence of NPS personnel in general.

The Robbins Committee[65] concluded:

"Research by the National Park Service has lacked continuity, coordination and depth. It has been marked by expediency rather then by long-term considerations. It has in general lacked direction, has been fragmented between divisions and branches, has been applied piecemeal and has suffered because of a failure to recognize the distinctions between research and administrative decision-making, and has failed to insure the

implementation of the results of research in operational management. Too few funds have been requested; too few appropriated. In fact, the Committee is not convinced that the policies of the National Park Service have been such that the potential contribution of research and a research staff to the solution of the problems of the national parks is recognized and appreciated".

The Committee submitted a series of recommendations to the NPS that included the following: define the objectives and purposes of each park; inventory and map the natural history resources of each park; make the distinction between administration, research and management; establish a permanent, independent and identifiable research unit in the NPS; the unit should be in a line arrangement with an Assistant Director for Research reporting directly to the Director of the NPS; most research by the NPS should be mission oriented and administered by the NPS; research should be designed to anticipate problems as well as to meet those problems already developed; each park should develop a research program; research should be consulted before any decisions are made on management operations affecting natural resources or public use; research should be conducted on aquatic life; research should pay attention to land uses and other economic activities adjacent to park boundaries; when justified research laboratories should be established in parks; the results of research should be publishable and published;

substantial additional financial support should be provided by the NPS for research.

The committee was appalled at the stinginess of the total national funding for research by the Service noting, "the Service budget for natural history research was $28,000 -- about the cost of one campground comfort station".[66] The committee also pointed out that the budget of the NPS for research was far less than 1 percent while that of comparable agencies was 10 percent. One area of conceptual (and management) importance recognized by the committee was that "each park is an ecosystem in which evolutionary processes need to be recognized and restored so as to preserve its unique features".[67] This statement was considered by many to be better articulated than similar ones by the Leopold Report.

Apparently, because of its critical nature, the Robbins Report did not get nearly the fanfare or circulation of the Leopold Report.[68] Further, although many of the recommendations of both reports were implemented within two years by the NPS [69] over time most of the recommendations of the Robbins Report were scrapped by the Service.

The third survey on the social-political-ecological problems of the parks was conducted by the Conservation Foundation. The two-man survey team consisted of Dr. F. Fraser Darling, an internationally known ecologist, and Noel D. Eichhorn, a noted geographer. Their report, independently supporting the

recommendations of the other two, was not published until several years later.[70]

Of these three reports, the one by the Leopold Committee had the most impact on changing the management policies of the National Park Service. It resulted in shifting the Service from looking at and managing park problems individually to looking at and attempting to manage parks in an ecosystem context. Unfortunately the committee's recommended primary goal of maintaining or recreating biotic associations within each park to near pristine conditions created enormous controversy. Many of the various publics involved as well as interested national parks management understood that this new philosophy was conceptual. However, there were those that believed it was to be taken literally. The result was as many opinions on how national parks should be managed as there were individuals with opinions. In any event, the Service, its managers and its scientists began new experimental programs to implement and evaluate the ecosystems concept of park management.

In 1963, partly in response to the new reports, the number of research biologists was increased to eight, the highest it had been since 1958. Implementation of the recommendations of the Robbins Report resulted in another reorganization of the research program. Ben Thompson was appointed the leader of research as Assistant Director of Resources Studies.

In 1964 the budget of the research program was increased from $28,000 to $80,000,[71] and a far-reaching organizational

event occurred in the NPS when Director Wirth stepped down from his position and was replaced by George Hartzog. Subsequently, Dr. George Sprugel, Jr. was appointed Chief Scientist of a new Division of Natural Science Studies in the Service's Washington D.C. office. Dr. Sprugel had been a program director at the National Science Foundation and was highly knowledgeable about research programs and their budget needs. Among other innovations he organized research teams to formulate Natural Sciences Research Plans for the parks.[72]

The first guidelines for preparing Natural Resources Management Plans were issued in 1965. These plans were aimed at implementing the recommendations of the Leopold Committee. The importance of the Science and Natural Resources plans has often been ignored by critics inside and outside the Service. These plans are forms of systems analyses. They systematically analyze problems that occur with components of park ecosystems, and they offer alternatives for correction. They attempt to integrate separate problems into a broader context, and they provide documentation for budgeting. The plans were to evolve in the future to greater sophistication, play a major role in providing an overview of the state of park resources at the national level, and serve as guiding documents for park resource and research programs. A National Science Research Handbook was also released during this period to give guidance in preparing research plans, and Science project funding was increased to $105,500[73] during the year.

In 1966, Dr. Sprugel's research teams completed research plans for Isle Royale, Everglades and Haleakala National Parks. Unfortunately Dr. Sprugel resigned during that year "feeling biology was not receiving the understanding and support he had been led to expect".[74] He was succeeded by Dr. A. Starker Leopold. Dr. Leopold was employed under a special appointment which allowed him to remain at the University of California. Dr. Robert M. Linn, formerly a NPS plant ecologist at Isle Royale National Park, was assigned to the Washington D.C. office as Deputy Chief Scientist to Leopold. Research project funding was increased to $177,000 that year.[75] Further, the NPS maintained excellence in its natural history publications with the appearance of Fauna No. 7, The Wolves of Isle Royale by L. David Mech in 1966, another classic work in wildlife ecology. Mech's research was under the direction of Dr. Durward Allen of Purdue University. After Mech's work Dr. Allen continued the wolf research effort with other graduate students. By the 1980s this program was recognized as the longest term predator/prey study in North America. Dr. Allen, a longtime friend of the NPS, served as a scientific advisor to the Service for many years.

In 1967 the science program underwent an improved reorganization. Renamed the Office of Natural Science Studies, it was placed directly under the Office of Director Hartzog, a move supported by the Robbins Committee.

For years millions of dollars had been spent by federal, state and local governments including the NPS to stabilize

coastal areas and beaches from the relentless forces of the oceans. The value, cost-effectiveness and broad applicability of research in national parks was clearly demonstrated by Godfrey and Godfrey[76], researchers from the University of Massachusetts who, in 1968, initiated a landmark study of coastal ecology, geology and management for the Service at Cape Lookout and Cape Hatteras, North Carolina. These researchers found that most stabilization projects did not work. Instead they often created new erosion or made natural erosion worse. The Godfreys concluded that the best management was not to fight the dynamic forces of nature of the barrier island system but to accept that islands will erode in one area and build up in another. They recommended that no permanent structures be constructed on the islands but if they were necessary, they should be inexpensive and expendable. The Godfreys' suggestions were implemented by the NPS and other agencies. A collaborator of the Godfreys, Dr. Robert Dolan, presented additional scientific findings and management recommendations in another report.[77] The work of these researchers had a tremendous impact upon coastal management and resulted in the saving of millions of dollars.

In 1968, a new Natural Resources Management Handbook was issued which detailed the preparation of Natural Resources Management Plans. Apparently during this period there was some Divisional vying for supremacy between Science plans and Natural Resource Plans. Eventually the NPS directed that research plans should be incorporated into this new planning document.[78]

Science and resources management planning became important because the leadership of the NPS knew that there was a need for some type of planning document for the parks which coordinated resources management and research, yet also could be tied in to the budgetary process and to the more comprehensive Master Plans (park development plans). However, after 1968 there followed a long period of trial and error in Natural Resources Plan development until a fairly satisfactory product was created in the early 1980s.

Also in 1968, a much-needed social science program was initiated by the Service.[79] Dr. Neil H. Cheek, Jr. was one of the first social scientists to be assigned to the new program. The Chief Scientist's "Annual Report", a document that outlined all the research being conducted throughout the System, was started in 1968. For that year, 764 research projects were reported. Many of these were being conducted by universities and other agencies with outside funding, but a substantial number were also being conducted by NPS personnel or with NPS funding. Regrettably, the Annual Reports were discontinued after 1977. During 1968, a national meeting of NPS researchers and management biologists was held at the Albright Training Center at Grand Canyon National Park. It was only the third conference of its type held since the Wright era.

At Sequoia and Kings Canyon National Parks an experimental fire management program was initiated in 1968 to restore fire as natural process. The sequoia communities were found by research

to be fire adapted, that is, dependent upon fires for maintenance and growth. Years of fire suppression had allowed unnatural fuels to build up in the sequoia groves, placing their survival at risk to large, uncontrollable wildfires. The management solution was to maintain the forest with small, prescribed (managed) fires. The research was carried out by Dr. Bruce Kilgore, an NPS scientist and prior student of Dr. A. Starker Leopold. The program was based upon the earlier work conducted in these parks by Dr. Richard Hartesveldt of San Jose State College and Dr. Harold Biswell at the University of California and their colleagues.[80] From Kilgore's work and the research at Everglades, the National Park Service began to demonstrate national leadership in the new field of fire ecology.

During the Hartzog era the multi-volume administrative handbooks which gave policy guidance to the agency were replaced with three small Administrative Policy handbooks. There was one each for natural areas, historic areas and recreational areas. Within the natural areas handbook[81] the entire report of the Leopold Committee was inserted, and a special directive was included making portions of the Report addressing game reductions NPS policy. Also included were a few general statements on research policy; however, the recommendations of the Robbins Committee were not included.

By 1970 Dr. Leopold had resigned and Dr. Linn had replaced him as the Service's Chief Scientist.[82] The number of field researchers had increased to about 35. Even so Linn recommended

the appointment of as many as 40 additional scientists for the field and proposed the development of a career ladder and a several-year training program for them.[83] A Research and Resources Management Conference was held at Grand Canyon in 1970.[84]

## SCIENCE FUNDING INCREASES AND DECENTRALIZATION OCCURS (1971-1980)

During this period there was a major reorganization and many small, but significant gains in funding, personnel and programs for Service science. Multimillion dollar interdisciplinary research projects became more common. There was an additional external review of the science program, but its impact was negligible.

In 1971 a major reorganization occurred at the Washington office level which has had long lasting effects on the science program. The program was decentralized. The Washington office Chief Scientist position was retained with reduced responsibilities, and seven Regional Chief Scientist offices were created with the notion of moving research closer to the parks.[85] The supervision of scientists stationed in the parks was shifted from the Washington office to the superintendents. This move scrapped a major recommendation of the Robbins Committee, i.e., that research should be independent of operational management.[86] It also wiped out science as a separate organizational entity in the Service. In effect the

move created a number of separate science programs, one at the Washington Office level and others at the Regional Offices. With a weak Washington Office policy each Region was free to have its own unwritten policies regarding research.

Also in 1971 a major controversy developed between Service scientists and independent researchers over the management of grizzly bears in Yellowstone. To be in conformance with the developing policy of "natural regulation" in the park, open pit dumps, which had been heavily used by grizzlies, were closed with the idea of shifting their feeding habits to natural foods. Drs. John and Frank Craighead who had been studying the grizzly in the park since 1959 as independent researchers, disagreed with this approach, recommending a slow phase out and intensive follow-up study instead. The conflict resulted in the Craigheads terminating their Yellowstone field research and publishing a series of articles suggesting that the grizzly population was declining drastically because of the new program.[87] Their claim was refuted by Service biologist Glen Cole.[88] This controversy reached national proportions and lasted for years.

The Conservation Foundation reviewed the Service's research program in 1972 as part of an overall survey of the agency and its administration of the parks.[89] It observed that some encouraging changes had been made since 1963 in regard to the research program but noted that neither the program nor funding were adequate to meet park needs.

In 1972 a NPS research center was initiated in cooperation with the National Aeronautics and Space Administration (NASA) at their Mississippi test facility. The Center was initially directed by Dr. Clyde Hurst and later by Dr. Garret Smathers, both Service scientists.[90] The purpose of the Center was to serve all NPS areas in three main areas of responsibility: natural landmarks studies, basic resources inventories, and ecological services. Although staffing reached 13 permanent and 21 temporary positions, the program was terminated four years later and the various personnel and functions were transferred to other areas within the NPS.

The Service has had a long history of affiliation with colleges and universities. There is a synergy in this kind of affiliation that stretches scarce research dollars and benefits both institutions. In 1971 a Cooperative Parks Studies Unit (CPSU) was established at the University of Washington. Its leader was Service sociologist Dr. Don Field. By 1973 a number of CPSUs were being established at various universities throughout the U.S. to assist park areas. The CPSUs were manned by NPS scientists, by university faculty or both, depending upon the circumstances. The scientists brokered research needs of the parks with the universities and conducted their own research projects as well. In time the program proved its value and the use of them increased so that by 1983 there were about 35 in operation.[91]

Director George Hartzog was replaced by Ronald H. Walker in 1973. In Walker's Washington office reorganization that followed Dr. Theodore Sudia was appointed Chief Scientist, and Dr. Linn moved to Michigan Technological University to coordinate Park research in the area. During the year the old Fauna Series was replaced by a Scientific Monograph Series, the first of which was Bison Ecology of Yellowstone by Mary Meagher. Also during this period, because of the Yellowstone Grizzly controversy, an Interagency Grizzly Bear Study Team was formed to fill the need for additional research. The team contained biologists from the NPS, the U.S. Forest Service, and the Montana, Idaho and Wyoming Fish and Game departments. Dr. Richard Knight, an NPS Scientist, was appointed leader of the team with NPS funding of about a quarter million dollars a year. Science funding increases for 1973 also allowed the Service to initiate a large scale multidisciplinary project at Grand Canyon under the leadership of Dr. Roy Johnson, an NPS scientist, to determine the interrelationships between whitewater recreationists and the sociological and natural environment.[92]

Gary Everhardt, superintendent of Grand Teton National Park, replaced Walker as Director in 1975. Under Everhardt a new policy manual was written which had clear-cut, but extremely brief, policy statements for an NPS science program.[93]

The First Triennial Conference on Research in the National Parks was held in 1976 at New Orleans. Because of the tremendous backlog of publication needs of park researchers, the conference

proceedings consisted of two large volumes containing 1325 pages of technical papers. Also during the year the scientific value of the U.S. National Parks was recognized by the international scientific community with designations of International Biosphere Reserves. This program, administered by the United Nations Educational, Scientific and Cultural Organization (UNESCO), emphasizes the research and educational value of outstanding conservation areas. By 1985 there were 22 NPS areas with Biosphere Reserve designation including Yellowstone, Denali, Everglades, Glacier, Rocky Mountain and other national parks.[94]

Director Everhardt was replaced by William J. Whelen, another NPS professional, in 1977, and he added a new and badly needed Air and Water Quality Division, under the leadership of Dr. Raymond Herrmann, to the Washington science program.

The largest research program in any National Park to date was initiated in 1977 at Everglades with the establishment of the South Florida Research Center. When the Center reached peak staffing it had 10 NPS scientists and about 25 technical staff.[95] Water, the driving force of the Everglades ecosystems, was being diverted before it reached the park for other uses. The Center's purpose was to develop an understanding of the Everglades ecosystem and its water needs so that a better water management plan could be developed for the beleaguered area.[96]

A multidisciplinary science and management program was created in Redwoods National Park in 1978 in response to the area's need for restoration of thousands of acres of intensively

logged and severely eroded lands recently acquired. About thirty three million dollars were programmed for the project which would take about ten to fifteen years to accomplish. At its peak the program would have about 22 permanent research and management staff and more than 50 temporary employees.[97]

In 1979 Dr. Sudia was replaced by Dr. Richard Briceland from the Environmental Protection Agency. The 2nd Triennial Research Conference was held in San Francisco, California. Also during the year a Research Personnel Evaluation Plan was instituted within the Service to provide promotional and pay increases based upon productivity. Under this program Service research scientists were subject to a review by a panel of peers at least every four years.

## THE SCIENCE PROGRAM EXPANDS ALTHOUGH INTERNAL AND EXTERNAL CRITICISM DEVELOPS (1980-1992)

External and internal threats to the parks became a national concern in 1979 and congress asked the Service for a report on the scope of the problems. The result was the State of the Parks Report which was submitted to Congress in 1980. The report identified over 4300 major threats to the resources of 326 parks. The most threatened resources were the general scene, air quality, mammals, plants and fresh water quality respectively. The report particularly pointed out the need for research, noting that seventy five percent of the threats were in need of research

for adequate documentation.[98] It also pointed out that only two percent of the NPS budget (twelve million dollars) was allocated to natural and cultural science programs; that there were less than 100 scientists or about 1 percent of the Service personnel working in research; and that only 200 NPS personnel were involved in resources management programs.[99] The report was alarming to Congress and the public and, as Olson[100] notes, resulted in a substantial increase in funding and personnel to address the most pressing problems. Ten million dollars in new funds were allocated for a Significant Resources Problem/National Recreation and Preservation Program (SRP/NRPP) and a new program was initiated to increase the Service's natural resources staffing by 100 personnel.

In the late 1970s and early 1980s the problems related to the administration of research by the Service and conflicts between superintendents and researchers began to receive increasing attention. Superintendents believed that scientists carried out overly-sophisticated studies not related to management needs and were not communicative. Researchers believed that managers did not seek researcher input in a timely way, involved them only in brush fire projects and placed science at the bottom of the funding priority list. Dr. Bruce Kilgore, Regional Chief Scientist of the Western Region, reviewed these differences and developed guidelines in an attempt to mitigate superintendent and researcher conflicts.[101]

Another problem area was identified by Mark Reshkin in a review of the science program in the Great Lakes parks. He found that with decentralization there was no overview; thus, there was a poor allocation and distribution of scientists in relation to areas with major problems.[102] A more detailed study of the Service's Rocky Mountain Region research by Katherine Kitchell and Dr. Rosemary Nichols of Utah State University revealed the same general problems noted by Kilgore and Reshkin.[103]

By 1985 the NPS science program had shown considerable growth. The ten regional science programs and the Washington Office had an annual budget of about 18 million dollars (about three percent of the NPS budget), and there were approximately one hundred and sixty scientists and technicians (about one and one-half percent of the total NPS permanent personnel). Of these however, only about 90 were qualified as research grade scientists. The fourth Park Science Conference was held in Ft. Collins, Colorado in 1986, and there a number of policy recommendations were developed to improve the role of science for the Service and submitted to Director Mott.[104]

In 1986 the book Playing God in Yellowstone by Dr. Alston Chase was published.[105] The book created considerable controversy. Chase, who has professional training in the philosophy of science and a 40 year association with the Yellowstone area, wrote the most scathing critique of the management of the park ever. In the book Chase, with indomitable logic, challenged, point by point, the basic tenets of the park's

management philosophy. The park's relatively new philosophy, primarily embracing the ecosystem concept and the concept of the natural regulation of plant and animal populations, was formulated by Yellowstone's biologists in response to the Leopold Report of 1963. Chase, from personal observation and the interviewing of hundreds of individuals from all walks of life who were familiar with Yellowstone (including university and government scientists, state and federal land managers, retirees, NPS personnel, ranchers, concessioners and others), contended that the park was being wrecked by the implementation of these concepts by park management.

He was particularly concerned with the historical destruction of the grizzlies, wolves and mountain lions in the park and alarmed by the large increases of elk and bison. He contended that the experiment of allowing these two large ungulate populations to control themselves by natural regulation, in the absence of large predators, had failed and was resulting in the reduction of lesser species such as bighorn, antelope, beaver and deer as well as causing excessive long-term damage to the vegetation and soil inside and outside the park.

Chase also claimed that Yellowstone's research and management had not adequately factored in the impacts of the hunting and burning of the area by the American Indian which maintained and shaped the park's ecosystems. He proposed that the park undergo "hands on" management such as elk and bison reduction and prescribed burning to reduce fuel loads and create

vegetational mosaics in the forest to counter years of fire suppression. He reasoned that Yellowstone's problems were part of a larger National Park Service problem. Thus, among other things, he proposed that the Service be overhauled to increase its professionalism in natural resources management and that the NPS increase its research capability by five times that at present. Although Chase's thesis was challenged by the National Park Service, Chase's book served to polarize advocates and opponents of the ecosystem management and research philosophy of Yellowstone and of the Service. This controversy of the research program and of letting nature take its course versus hands on management still rages on.

In 1987 Dr. Briceland stepped down, and Dr. Eugene Hester from the U.S. Fish and Wildlife Service took over the position of Associate Director for Natural Resources for the Service; this included the leadership of the NPS science program.

The National Parks and Conservation Association (NPCA) published a 9 volume National Park System Plan in 1988. The Plan was a three-year effort utilizing professionals within and outside the Service. It identified problems with the Service and with the National Park System and made recommendations to correct them.

Volume two[106] was devoted to research. It noted that the research program in the NPS was struggling for an identity and that the program was underfunded, understaffed, and fragmented. The report's recommendations included the need for Congress to

mandate research for the agency through legislation and the increase of research funding to about ten percent of the Service's budget. The NPCA noted that other natural resources agencies such as the U.S. Forest Service and Fish and Wildlife Service had long-standing, centralized, well-funded research programs and questioned why the National Park Service should not have their equal. Although more sophisticated and detailed, this report identified many of the same persisting problems with NPS research that the Robbins Committee had identified 25 years earlier.

During the summer of 1988 severe drought conditions in Yellowstone National Park resulted in a series of major forest fires. These eventually burned nearly 1 million acres of the 2.2 million acre park, threatening areas such as Old Faithful and the gateway town of Cooke City.[107] There was a tremendous public outcry and debate over the Service's fire policy. Although Director Mott, the Service and the scientific and environmental communities defended the fire policy for the park, i.e., that of letting lightning fires burn under certain conditions, the political pressure against it was too great. Suppression was ordered for all fires in the park in the future. This created concern that the overall Service's fire policy of prescribed burning, gained by painstaking research and experimentation, would be at risk.

In the 1980s there was again a succession of Service Directors. In 1980 Russel Dickenson, an old-line Service

employee, replaced Whelen. He was followed in 1985 by William Penn Mott, Jr., who had previously been director of the California Parks program. In 1988 James Ridenour, previously a director of the Indiana Department of Natural Resources, became the new Service Director. In a significant move, Ridenour made the support of the science program one of the five top priorities of his administration. By 1990 the Service had grown enormously as compared to the early days. There were 350 units in the National Park System with a visitation of nearly 270 million a year, and the Service had a budget of over 850 million dollars.

In 1990 the NPS initiated the development of a blue ribbon committee, organized along the lines of the Leopold and Robbins Committees, by the National Academy of Science to assess the NPS science program. The findings and recommendations of this committee are still pending. On October 7 - 10, 1991, the National Park Service's 75th Anniversary Symposium was held at Vail, Colorado. The symposium, which included NPS officials and the Service's numerous publics, assessed the organizational and policy problems of the NPS. Among the recommendations that resulted from the symposium were several which, if implemented, would strengthen the NPS science program.[108] As a final note, in 1991 the NPS published and distributed its Natural Resource Management Guidelines (NPS - 77).[109] In it is a section on research policy and administration which reiterates the brief NPS policy on research and which, for the first time, provides a

thorough overview of the elements of the Service's science program and how they are managed.

In summary, the science program of the national parks originated in the late 1800s from natural history research conducted in the quest for knowledge for its own sake and from the need to provide information to park visitors. Later, in the 1930s, with the entry of George Wright, scientific research was used to provide information for park managers on wildlife and other natural resources management issues. Under Wright's leadership the program expanded through the late 1930s primarily in concert with the New Deal's Civilian Conservation Corps (CCC) work in the parks. Wright's untimely death in 1936, however, resulted in a loss of political support for the program. The federal funding and manpower cutbacks of World War II finished it. For many years after the war the science program was not emphasized and a mere handful of researchers and park interpreters attempted to fill the void. Thus, from the late 1930s into the early 1960s, nearly a quarter of a century, a hiatus of scientific research existed in the parks with only minimal manpower and funding being expended on it. This resulted in an enormous backlog of park scientific information needs, and the Service has been playing an unsuccessful catch-up game ever since.

Beginning in 1963, from the influence of the Leopold and Robbins Reports requested by Secretary of the Interior Udall, the science program of the NPS was centralized and expanded

particularly to support resources management, but also interpretation and planning. The Leopold Report, conceptualizing a new ecosystem concept of park management, was the most influential document to shape Service management policy since Wright's work of 1933. Its influence has continued to the present day. The Robbins Report, outlining a science program, possibly because of its criticism of the Service, did not receive comparable long-term acceptance.

In 1971 the NPS reorganized and decentralized the science program, a move contrary to the recommendations of the Robbins Committee. This organizational framework has continued to date. Following this the overall Service science program still received increases in funding and personnel. During the 1970s there were a number of positive steps taken by the Service to improve the program, such as the development of Park Studies Units in coordination with universities and the increasing support of national park science meetings to transfer new research and management technology throughout the field. In 1980 the State of the Parks Report, submitted to Congress, was a landmark document. For the first time there was a comprehensive overview of park research needs servicewide. The report demonstrated, beyond doubt, the enormous backlog of research needs of the parks (nearly 75 percent of 4300 threats to parks were in need of research). This resulted in large increases in funding and support of Service resources management and research programs, a

support that has continued to the present time but still is considered to be inadequate.

A number of reviews have been made of the Service's science program over the years; the Robbins Report of 1963, the 1967 report of Darling and Eichhorn; the 1972 report of the Conservation Foundation and more recently the 1988 report of the National Parks and Conservation Association. Additionally many internal reports of park scientist groups have been submitted to the Director. Nearly all of these reports have been critical of the Service's handling of research yet have offered constructive reform. Unfortunately, the recommendations, particularly those of the Robbins Committee, although partially implemented afterward, were never incorporated into formal NPS policy or set into accountability and, because of this, have been forgotten or lost in time. The 1971 reorganization of research has been viewed by critics as an organizational setback, resulting in the loss of organizational cohesion and identity of Service science. Critics claim that Regional Offices and parks have been free to make their own policy regarding science in lieu of a national policy. This has contributed to mercurial, boom and bust periods of the field science programs depending upon the whims of individual Regional Office and park managers who traditionally have had high position turnover rates and have a spotty record of support for science. Supporters of the reorganization claim that it has placed research under the control of management where it is closer to real park problems. An additional advantage is that

the program is "hidden" in the budget from the raids of periodic line item budget cutting.

There has been and always will be an inherent conflict between operational management and research because their roles and values are different. This has been recognized for many years in management theory in the private sector.[110] Obviously, there is a continuing need for the NPS to manage and organize these conflicting roles constructively.

Possibly because of decentralization, the Washington Office has been accused of being powerless to implement any new research policy at the national level. Critics claim that the lack of policy and overview regarding organization, funding, and personnel has resulted not only in fragmentation and destabilization of the program but, in some cases, inefficient use and distribution of scientists and funding in regard to serious park problems. Concern has been expressed at the small size of the Service's science program in relation to the considerable information needs stemming from serious threats. There are efforts being made by the Service to improve the science program; however, the program appears to be in its adolescence rather than in its maturity as compared to other agency (Forest Service, Fish and Wildlife Service) science programs. Again, the reasons for this go beyond decentralization and policy needs. The "revolving door" succession of Service Directors and their appointed science program leaders has undoubtedly been a destabilizing influence.

Each Service Director has brought his own attitudes on research to the job and has left his mark on the program, sometimes favorable, sometimes not. Further, in addition to minimal NPS policy on a research program and accountability controls in the maintenance of it there have historically been persisting problems in funding, organization, leadership and internal acceptance. Many NPS operational leaders (Directors, Regional Directors and Superintendents) know that research is needed in the parks; thus, there is at least a minimal base of internal support for it.

The role of park science has not only changed over time but historically there has been a shift from the individual scientist conducting research in a park toward multidisciplinary research projects utilizing large numbers of researchers. This has been in response to the increasing complexity of research problems in the parks.

National Park Service researchers have been at the forefront in attempting to develop a model of managing parks on an ecosystem scale as envisioned by the scientists who conceptualized the Service's role in the Leopold Report. The concept has been controversial, and even today the philosophy of managing natural areas is undergoing evolution. Although considerable progress has been made, the technology and methodology of this form of land management is still being developed by trial and error and by experimentation. These efforts are literally at the cutting edge of technology. The

concept is not only being evaluated and tested by the scientific community (by Service and external scientists) but is being criticized by the same as well as by laymen, philosophers, and others. A new model or philosophy in regard to how national parks and other natural areas in the United States should be managed, beyond that of the Leopold Report, has yet to be established.

Scientists have been criticized by park managers as being uncommunicative and conducting studies not related to management needs. This is unfortunate because many NPS scientists are recognized nationally and internationally as being among the best in the world involved in developing the new technology and research programs for natural areas preservation. They have shown research leadership in subjects as diverse as predator-prey relationships, coastal barrier ecology, fire ecology, species restoration, recreational sociology and genetic diversity.

Service scientists have had an unpopular role to play because they may, at times, threaten the status quo. Their objective scrutiny of entrenched park management practices such as total forest fire suppression and predator control in the parks have resulted in major policy changes. Their critical reviews of potential resource impacts from park development schemes over the past 50 years have not endeared them to park managers and have, in some cases, created a climate of mistrust. Yet, there is little doubt of the tremendous impact on NPS policy created by the Leopold Report, a report developed by scientists.

It is a given however, that NPS managers (Directors, Regional Directors and Superintendents) demonstrate management capability and have many years of preservation experience in the parks. The acceptance and efficient management of the Service's science program is dependent upon them.

This account of Service science has, out of necessity, listed many seemingly small changes in funding, Service Directors, science leaders and science organization in a chronological order. These changes may seem small, but cumulatively they have had significant impacts on the Service's research program -- sometimes for the better, sometimes for worse. From this historical review however, it is painfully evident that the Service, over the years, has been in a near continual state of experimenting with and grappling with the problem of how to best administer the science program to meet park information needs.

National Park Service historian William Brown, in a review of the situation, once asked in frustration why the Service's science program appeared to be some sort of appendage in reverse that could not be grafted upon the NPS body.[111] Apparently only time will provide the answer. It remains to be seen what the future holds for the science program in the Service and how this proud, old-line federal agency will respond to the research needs of the parks in the dawn of the twenty-first century.

NOTES

1. National Park Service, Administrative Policies, Natural Areas, U.S. Department of the Interior, Washington, D.C. (1970). 12.

2. Ibid., 100.

3. Barry MacKintosh, Interpretation in the National Park Service--A Historical Perspective, History Division, National Park Service, U.S. Department of the Interior, Washington, D.C. (1986).

4. Ibid.

5. Robert D. Shankland, Steve Mather of the National Parks (New York: Alfred A. Knopf, 1951). 158.

6. Lowell Sumner, "Biological Research and Management in the National Park Service: A History", The George Wright Forum, 4th ser., no. 3 (1983): 4. (Reprint of a manuscript dated May 1967.)

7. Joseph Grinnell, J. S. Dixon and J. M. Linsdale, Vertebrate Natural History of a Section of Northern California Through the Lassen Peak Region (Berkeley: Univ. of California Press, 1930); Joseph Grinnell and T. I. Storer, Animal Life in the Yosemite (Berkeley: University of California Press, 1924).

8. Sumner, "Biological Research", 4.

9. Shankland, Steve Mather, 259-260.

10. Ibid., 261.

11. Ibid., 261.

12. Ben H. Thompson, "George M. Wright 1904-1936", The George Wright Forum, 4th ser., no. 4 (1986): 1-2.

13. George M. Wright, J. S. Dixon and B. H. Thompson. Fauna of the National Parks of the United States: A Preliminary Survey of Faunal Relations in National Parks, Volume 1. (Washington, D.C.: U.S. Government Printing Office, 1933).

14. Sumner, "Biological Research", 6-7.

15. Wright, A Preliminary Survey.

16. Sumner, "Biological Research", 7.

17. Ibid., 8.

18. Ibid., 10.

19. Aldo Leopold, Game Management (New York: Charles Scribner Sons, 1933).

20. Sumner, "Biological Research", 5.

21. Horace Albright, "Research in the National Parks", The Scientific Monthly, June (1933).

22. Sumner, "Biological Research", 10.

23. Gordon C. Olson, "A History of Natural Resources Management Within the National Park Service" (M.S. Thesis, Slippery Rock University, Arkansas, 1986) 185.

24. Sumner, "Biological Research", 9.

25. Ibid., 14.

26. Garrett A. Smathers, "Historical Overview of Resources Management Planning in the National Park Service". Paper presented at the 26th Annual American Institute of Biological Sciences meeting on Biological Societies, Symposium: Natural Resources Planning in the National Park Service II, (August 21, 1975).

27. Sumner, "Biological Research", 13.

28. Olson, "A History", 78.

29. Sumner, "Biological Research", 9.

30. Thompson, "George M. Wright", 4.

31. Sumner, "Biological Research", 6.

32. Ibid., 14.

33. Ibid., 14.

34. Adolph was the brother and brother-in-law, respectively, of Olaus and Mardie Murie, also renowned for their conservation and Wilderness Society work.

35. Sumner, "Biological Research", 14.

36. Adolph Murie, Ecology of the Coyote in the Yellowstone, Fauna Series No. 4, National Park Service (Washington, D.C.: U.S. Government Printing Office, 1940).

37. Sumner, "Biological Research", 15.

38. Ibid., 14.

39. Olson, "A History", 104.

40. Sumner, "Biological Research", 15.

41. James E. Katz, Presidential Politics and Science Policy (New York, London: Praeger Publishers, 1978) 6.

42. Sumner, "Biological Research", 15.

43. Ibid., 16.

44. National Academy of Sciences, "A Report by the Advisory Committee to the National Park Service on Research" (Washington, D.C., National Research Council, 1963)--the "Robbins Report".

45. Sumner, "Biological Research", 14.

46. Olson, "A History", 127.

47. National Academy of Sciences, "A Report", 27.

48. Ibid., 29.

49. Neil J. Reid, "Some Reflections on a Career", Park Science, 1st ser. No. 6 (1985):15.

50. William C. Everhart, The National Park Service (New York, Washington, London: Praeger Publishers, 1972):36-37.

51. Sumner, "Biological Research", 17.

52. Ibid., 17.

53. Olson, "A History", 140.

54. Bruce Kilgore, "Fire Management in the National Parks: An Overview", in Tall Timbers Fire Ecology Conference (1974):47-48.

55. National Academy of Sciences, "A Report", 29.

56. Ibid., 29.

57. John J. Craighead, Personal communication with author, June 1, 1988.

58. Sumner, "Biological Research"; National Park Service, Administrative Policies (1970); National Academy of Sciences, "A Report"; Smathers, "Historical Overview"; Olson, "A History".

59. National Park Service, Administrative Policies (1970), 109.

60. Ibid.

61. Ibid.

62. Ibid.

63. Sumner, "Biological Research", 19.

64. National Academy of Sciences, "A Report".

65. Ibid., 31.

66. Ibid., 32.

67. Smathers, "Historical Overview", 9.

68. F. Frazer Darling and N. C. Eichhorn, Man and Nature in National Parks--Reflections on Policy (Washington, D.C.: The Conservation foundation, 1976), 11.

69. Olson, "A History", 161.

70. Darling and Eichhorn, Man and Nature.

71. Sumner, "Biological Research", 20.

72. Ibid., 20.

73. Olson, "A History", 17.

74. Sumner, "Biological Research", 21.

75. Ibid., 21.

76. Paul J. Godfrey and M. M. Godfrey, Barrier Island Ecology of Cape Lookout National Seashore and Vicinity, Scientific Monograph Series No. 9. National Park Service (Washington, D.C.: U.S. Government Printing Office, 1976).

77. Robert Dolan, "Barrier Islands: Natural and Controlled", in D. R. Coates, Ed. Coastal Geomorphology (Binghampton, N.Y.: State University of New York, 1973).

78. Smathers, "Historical Overview", 11.

79. Olson, "A History", 142.

80. Kilgore, "Fire Management", 48-49.

81. National Park Service, Administrative Policies.

82. Smathers, "Historical Overview", 11.

83. Olson, "A History", 175-176.

84. Ibid., 186.

85. Ibid., 174-175.

86. Smathers, "Historical Overview", 11-12.

87. John J. and F. C. Craighead, Jr., "Grizzly Bear-Man Relationships in Yellowstone National Park", BioScience, 21st ser., No. 16 (1971):845-847.

88. Glen F. Cole, "Preservation and Management of Grizzly Bears in Yellowstone National Park", BioScience, 21st ser., No. 16 (1971):858-864.

89. Conservation Foundation, National Parks for the Future (Washington, D.C.: The Conservation Foundation, 1972).

90. Olson, "A History", 206-209.

91. James K. Agee, D. R. Field and E. E. Starky, "Cooperative Park Studies Units: University-Based Science Programs in the National Park Service", Journal of Environmental Education, 2nd ser. No. 1 (1982):6-7.

92. R. Roy Johnson, "Riparian Management and the Colorado River", Park Science, 2nd ser. No. 1 (1982):6-7.

93. National Park Service, Management Policies, U.S. Department of the Interior (Washington, D.C.: National Park Service, 1975).

94. Olson, "A History", 222-223.

95. Gary Hendrix, "Ever Tougher Fight Faces Everglades over Water Rights", Park Science, 2nd ser. No. 4 (1982):12-13.

96. Ibid.

97. Robert D. Belous, "A View from Redwood Creek: Learning By Doing", Park Science, 4th ser. No. 2 (1984):3-6.

98. National Park Service, State of the Parks-1980: A Report to the Congress (Washington, D.C.: National Park Service, 1980).

99. Ibid.

100. Olson, "A History", 224-225.

101. Bruce M. Kilgore, View on Natural Science and Resource Management in the Western Region (Seattle, Wash.: NPS

Cooperative Parks Studies Unit, College of Forest Resources, University of Washington, 1978):1-12.

102. Mark Reshkin, "The Role of Science in the Great Lakes National Parks", The George Wright Forum, 4th ser. No. 3 (1982):18-23.

103. Katherine P. Kitchell, "A Needs Assessment-Based Review of the National Park Service Science Program in the Rocky Mountain Region", The George Wright Forum, 5th ser. No. 1 (1987):21-22; Katherine P. Kitchell and R. Nichols, "Scientists, Superintendents Differ on Researcher's Role in R.M. Region", Park Science, 7th ser. No. 2 (1987):4-5.

104. Raymond Herrmann, "The Failure of Science in the National Parks", The George Wright Forum, 5th ser. No. 3 (1987):1-13; Jim Wood, "Improving the Role of Science in the National Park Service", Park Science, 8th ser. No. 2 (1988):22-23.

105. Alston Chase, Playing God in Yellowstone. (San Diego, New York, London: Harcourt Brace Jovanovich, 1987).

106. National Parks and Conservation Association. Research in the National Parks: An Assessment. Volume 2 (Washington, D.C.: National Parks and Conservation Association, 1988).

107. Robert Ekey, and staff of Billings Gazette, "Yellowstone on Fire!" (Helena: Falcon Press, 1989).

108. National Park Service, "Our National Parks: Challenges and Strategies for the 21st Century", National Park Service 75th Anniversary Symposium (Washington, D.C.:National Park Service, Department of Interior, November, 1991) 37pp.

109. National Park Service, Natural Resources Management Guideline (NPS-77), (Washington, D.C.:National Park Service, 1991). (5):2-17.

110. Charles D. Orth III, " The Optimum Climate for Industrial Research", Harvard Business Review, March/April 1959: 55-64.

111. William E. Brown, "Historical Perspective", The George Wright Forum, 5th ser. No. 1 (1986):22-24.

ILLUSTRATIONS

1. Early 1930s photograph of youthful George Wright using state-of-the-art land camera at Yosemite National Park. Wright was instrumental in establi ıing the program of research and scientific management in the National Park Service.

2. Park scientist H. McCutchen conducts black bear research in Rocky Mountain National Park in the 1980s utilizing state-of-the-art radiotelemetry and satellite imagery.