BIOLOGICAL RESEARCH AND MANAGEMENT IN THE NATIONAL PARK SERVICE: A HISTORY

Lowell Sumner

Why This Report?

The year 1967 appeared to signal the end of a 25-year period of isolation and frustration for biological research and management in the United States National Park Service. Prospects for understanding and support seemed the best since 1936, when they had been very bright.

During the intervening period those who helped to initiate and shape the Service's biological goals and programs had retired, transferred to other work, or passed away; successive reorganizations had largely obliterated traces of the continuity of ancestry between the early group which established modern concepts of ecological research and management for the national parks, and the recently created Office of Natural Sciences.

Since the writer was one of the last of the early group still functioning as a Service biologist, he was asked to record the Office's antecedents in order to clarify how we arrived where we are today--and what lessons can be learned from this history.

A Cycle of Ups and Downs–Its Cost Was Too High

The pioneering achievements and bright prospects of the early '30s were cut short by tragic circumstances beyond anyone's control. But the recovery period might have been accomplished in five years, if ecological understanding had prevailed more widely, instead of requiring a quarter of a century.

Some cycles in human activities can be tolerated because they are not harmful, or may bring relief. For example, periods of organizational decentralization may follow periods of centralization, each relieving certain accumulated stresses, with perhaps little lasting harm to the organization.

But cycles of attention and relative inattention to biological malfunctioning of the land resources in parks are in a different category. Just as with warning signals in human health, if critical land resource situations remain undetected, or ignored, beyond a certain point, they may finally become irreversible.

In the last 25 years, as pointed out by the National Academy of Sciences in its 1963 report (p. 15), the ecological health of some parks has come close to this point of no return. Particularly in the case of parks with desert vegetation which has restricted powers of recovery, and parks where the Service is losing control of the quality and quantity of ecologically critical water supplies, the cost of one cycle of inattention was too high. Under present ecological pressures from the outside, an-

other such cycle would certainly result in the ruin of more than one national park. Hopefully, this is what we can learn from history.

The Beginnings of Ecological Understanding

Joseph Grinnell and Aldo Leopold. The young science of ecology got its start even before the establishment of the National Park Service, as illustrated by the classic ecological surveys of Isle Royale in 1904 and 05 by Charles C. Adams (1906, 1908). But it did not begin to clearly affect the management concepts of the National Park Service until the '20s when a generation of younger administrators and technicians became influenced by the teachings and philosophies particularly of Joseph Grinnell, pioneer vertebrate ecologist at the University of California, and Aldo Leopold, father of modern wildlife management in the United States.

Joseph Grinnell's concept of refraining from interference with the unfolding of natural ecological succession in the national parks was introduced directly into Service thinking through some of his former students, who included Harold C. Bryant (Assistant Director, and first Chief of the Branch of Research and Education); George M. Wright (first Chief of the Wildlife Division, which was this Office's direct ancestor); Ben H. Thompson (formerly of the Wildlife Division, and subsequently, Assistant Director); Joseph S. Dixon (the Service's famed Field Naturalist); former National Park Service biologists Adrey E. Borell, James O. Stevenson, and the writer.

Unquestionably, Grinnell's voluminous published writings, which included recommendations concerning the ecological administration of national parks, also influenced or reinforced the attitudes of many other National Park Service biologists, and some administrators, of that generation. In the books he co-authored on Yosemite (1924) and Lassen (1930) National Parks, and on Point Lobos State Park (1936), he clearly indicated why the highest purpose of such parks should be the preservation of their natural conditions and continued evolution as free as possible from all unnecessary human interference.

For ecological reasons that were always cogently expressed, he urged that in such parks no trees, living or dead, be cut, and no understory removed beyond that necessary for eliminating an immediate fire hazard.

Native burrowing animals that often are considered pests elsewhere, he believed should be permitted in the parks to perform, unhindered, their vital function in soil formation and aeration. Carnivorous animals, he said, should be allowed to perform their natural function of eliminating the diseased and unfit--so that, in the parks, those who care for such things can enjoy and study the unfolding natural relationships that are involved.

Joseph Grinnell's contributions to the philosophy of the Service's developing biological concepts emphasized ecological inter-

dependence and lack of unnecessary interference. One of the first fruits of his influence was gradual abandonment in the '30s of the old-fashioned practice of controlling "predators" in the parks to "save" the "game".

Aldo Leopold's influence on park thinking began to manifest itself a few years later and probably was even more profound. Its ramifications continue virtually undiminished--in fact materially augmented and strengthened by the work of Starker Leopold--even today.

Basic to Aldo Leopold's thinking was the concept that man is so rapidly and profoundly altering the original natural environment that if he wants to save and enjoy any particular species of plant or animal--or (in the case of wilderness and parks) the natural environment as a living whole--he must learn how to specifically manage the species, the environment, and himself, for that scientifically planned purpose.

Aldo Leopold's pioneering book "Game Management" (1933) became, and remained, a principal reference and working tool for practically every professional wildlife biologist, including those in the National Park Service. This book has never been rendered out of date by the subsequent work of others--just enlarged on.

Some of Leopold's subsequent writings have focussed still more directly on the value of wilderness and wild things to man, and it is significant that he was in large measure responsible for the ultimate establishment of the Gila National Wilderness--first and one of the largest of its kind. His "Sand County Almanac" (1949) with its emphasis on the need for development in this country of a mature, ecologically oriented land ethic, continues to inspire and strengthen the backbone of many park biologists.

First Organizational Steps in Biological Resource Management

The naturalist program of the National Park Service had been undergoing a parallel development, from the early impromptu campfire entertainment phase toward more professional, scientific interpretation. In 1929 an advisory Committee on Educational (meaning interpretive) Problems in the National Parks recommended a research program to fill some of the vast gaps in the scientific information that would be required for improved interpretive programs.

In response to these recommendations, a new Branch of Research and Education was created, July 1, 1930, and Dr. Harold C. Bryant (as we have seen, an associate of Joseph Grinnell), was enticed away from a comparable position in the California Department of Fish and Game to head it up.

George M. Wright. Concurrently, in 1928 and 1929, another Grinnell student--through his association with the University's program of field studies of national parks, and also with the Service's interpretive program at Yosemite--became deeply concerned over the many symptoms of ecological deterioration which he observed. This was George M. Wright, who in the next few

years became one of the most vigorous and promising leaders of his time in developing a more general appreciation of the value to society and to science of national parks in an unimpaired state--and the magnitude of the task.

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. His park by park description of environmental problems, and the management programs proposed for their solution, could pass for surveys and plans made in 1967. However, the spectacular success which during his brief career attended his efforts to win acceptance of his ideas and programs on behalf of the parks, was due even more to his sunny and persuasive personality than to his scientific attainments.

Since he was independently wealthy, his efforts were not hampered by the subservience of position and status that often is experienced by pioneers and original thinkers in an organizational hierarchy. In addition, the most effective of all his attainments and characteristics was his warm, relaxed, unselfconsciously friendly personality. Rangers in the back country were on the same first name basis with him as luminaries in the Administration or in the Cosmos Club and Bohemian Club.

But no matter how many reminiscenses might be recorded concerning George Wright's disarming diplomacy, 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. To succeed, such an innovator would need an extraordinary talent for persuasiveness, or some good friends in high places. Although George relied mainly on the first, he had both. In addition he had rare good luck as well as judgement in timing his efforts to take advantage of developing national resource programs.

The Preliminary Wildlife Survey

The first step in Wright's program, undertaken in 1929, was on his own initiative, and involved the organization and personal financing of a preliminary wildlife survey of all of the national parks, from an ecological and management point of view. He borrowed Joseph S. Dixon, nationally famed field biologist, from the University of California, signed up (1930) Ben H. Thompson, who had just graduated from the University, as research associate, rented an office in downtown Berkeley, hired stenographers, paid all salaries during the initial phases, and bought all field equipment for a major field expedition. Its purpose: "In addition to treating of the vertebrate natural history of the parks still needing basic surveys, (it) will cover research in one branch of science that is the very foundation upon which the National Park Service is built, namely the preservation of the native

values of wilderness life. For it is this ideal above all else which differentiates this service from its sister services in government," (National Park Service Fauna No. 1, p. iv).

It was characteristic of Wright's approach that he sought and obtained in advance the approval and "personal guidance of Director Horace M. Albright" for this survey, as well as the advice of Joseph Grinnell and that of the Service's field naturalist Carl P. Russell.

This survey took approximately three years for completion. In 1931, toward the close of the field work, office space was made available for the staff and its records in quarters on the University campus occupied by field offices of the Branch of Research and Education. Thereafter the survey's operations were gradually integrated into and increasingly financed by that Branch as an official National Park Service function.

In January 1932 Wright's Berkeley office was formally established in the Branch of Research and Education as a new Wildlife Division; Wright received the official title of Chief not long after. In the meantime, arrangements already had been made to publish the findings and recommendations of the survey in two official government documents, Faunas No. 1 and No. 2 of the National Park Service. About this time another position, Supervisor of Fish Resources, was established, with headquarters at Salt Lake City. It was occupied by David Madsen, previously a Utah Fish and Game Commissioner. Early in 1935 Wright's office was transferred to Washington, and Ben Thompson followed shortly. Joseph Dixon remained at the Division's office on the Berkeley campus until regionalization of the Service in 1936 caused it to be moved to the Service's Fourth Regional Office in San Francisco. The present writer joined the Berkeley staff in March 1935.

"Conservation Is Not Enough"

That the Preliminary Wildlife Survey was in the forefront of its time and in tune with modern concepts, is apparent from the opening remarks of Fauna No. 1: "...intensification of the protective function until...poaching has been reduced to a minimum...has not been enough. The need to supplement protection with more constructive wildlife management has become manifest with a steady increase of problems both as to number and intensity...

"The policy of non-interference with wildlife became more and more deeply intrenched. Protection would do the rest. Nevertheless, time proved that management of some sort would have to be invoked to save certain situations, especially as the parks were opened to thousands of visitors, causing a flood of fresh complications.

"The conclusion was unavoidable. Protection, far from being the magic touch which healed all wounds, was unconsciously just the first step on a long road...to restore and perpetuate the

fauna in its pristine state by combating the harmful effects of human influence.

"The park faunas face immediate danger of losing their original character and composition unless the tide can be turned. The vital significance of wildlife to the whole national park idea emphasizes the necessity for prompt action. The logical course is a program of complete investigation, to be followed by appropriate administrative action.

"The unique feature of the case is that perpetuation of natural conditions will have to be forever reconciled with the presence of large numbers of people on the scene, a seeming anomaly. A situation of parallel circumstances has never existed before. Therefore the solution cannot be sought in precedent. It will challenge the conscientious and patient attention of biological engineers. And because of the nature of the task, it is inherently an inside job. *Constancy to the objective can be made a certainty only by employment of a staff whose members are of the Service, conversant with its policies, and imbued with a devotion to its ideals.* [Italics by the present writer.]

"The only hope rests in restoring the original vessel (biological integrity of the parks) to wholeness...failure here means failure to maintain a characteristic of the national parks that must continue to exist if they are to preserve their distinguishing attribute. Such failure would be a blow injuring the very heart of the national park system." (Fauna No. 1, pp. 2-6).

Although these particular statements of concept and objective do not explicitly spell out the Service's concern for the parallel restoration of the vegetative habitat on which the wildlife is utterly dependent, the overall content of Faunas 1 and 2 clearly does.

A responsibility of the historian, in addition to tracing antecedents and summarizing the development of significant courses of events, is to bring to light the lost and forgotten documents which helped to shape those events. That is the reason for presenting the foregoing quotes.

Fauna No. 1 went on to analyze the major ecological situations and problems prevailing in each park in the late '20s and early '30s, making specific management recommendations as well as urging more research. It devoted considerable attention to the Yellowstone elk situation, which had been cause for concern since 1911, warned of further range destruction, urged control as well as more research.

The Wildlife Division–Direct Ancestor

The Wildlife Division, established in 1932, was the first organizational unit created by the Service for the sole purpose of planning, reviewing, and assisting in ecological research and management of the biological resources; as such it was also the first direct organizational ancestor of the present Office of Natural Sciences. Ben Thompson became Assistant Chief of the

Division on being transferred to Washington, but soon he was promoted out of the new organization to become a special assistant to the Director and was replaced by Victor H. Cahalane.

The CCC. At this juncture a new development presented the National Park Service with a far-reaching opportunity for expanding its conservation role on the national scene. This was the creation, in the Depression, of the Civilian Conservation Corps for training underprevileged youths in new job skills. CCC camps for teaching the boys methods and techniques of land conservation were established all over the country; many were placed in the national parks, and even more in State parks. The National Park Service was responsible for supervision of CCC camps in the State as well as the National Parks.

Since the small, old-line staff of park administrators and planners could not possibly handle the Service's share of this vast program without large increases in funding and manpower, CCC funds were used for the necessarily extensive additional staffing as well as for operation of the camps themselves. As a result it was estimated (unofficially) that by the end of the '30s some two-thirds of the Service's total annual expenditures were being financed with CCC funds.

George Wright was not one to miss such an opportunity, especially since conservation groups were expressing concern that the CCC programs, unless adequately supervised, might inflict severe damage upon the unique and fragile ecological resources of the parks.

By 1936 there were 27 (4 regular, 23 CCC) biologists (then called Wildlife Technicians) on the Wildlife Division staff. Some of these were headquartered in the parks, but in conformity with the Service's overall regionalization in 1936, many, including the present writer, were placed in the regional offices (see appendix) and given responsibility for the supervision of extensive field territories. (The number shrank after 1936.)

Other divisions and branches of the Service were able to expand in like fashion, particularly in the fields of landscape architecture, engineering and forest protection (the latter has been traditionally maintained as an organization separate from the Wildlife Division, and operated under a separate administrative head).

How Did the Biologists Operate?

In retrospect it has often seemed almost incredible that during the CCC program the biologists were required to review all proposed management and development projects involving wildlife or its habitat, in the parks for which they were responsible, and to check on the ground any proposals that might adversely affect natural values. Such projects had to be cleared in those days by the biologists as well as by the landscape architects and engineers before they could be approved at higher levels. The same was true with regard to new areas proposed for

inclusion in the National Park System, as well as boundary changes under consideration for existing areas.

The National Academy of Sciences' report of 1963 states (p. 69): "Consultation with the research unit in natural history of the National Park Service should precede all decisions on management operations involving preservation, restoration, development, protection and interpretation, and the public use of a park." This requirement was imposed by the Washington Office about 1934 and remained generally in effect until World War II.

The Academy's report also recommends, "that communication between research personnel should be direct from field to the Office of the Chief Scientist. Regional offices serve as useful supporting services to field research activities, but the direction of the professional scientific research program should center on the Office of the Chief Scientist." Such an organizational relationship between the Chief of the Wildlife Division and the regional and field biologists did prevail from 1934 until World War II.

The twenty wildlife policies shown on pages 147-8 of Fauna No. 1 as "suggested" were immediately adopted by the Service as official (and remain in effect today). Each biologist was provided with a copy of this publication for his guidance in overall policy and for application to many of the major biological maladjustments of his particular territory. It remained the working "bible" for all park biologists until after World War II, when it went out of print, was not reissued, and became largely unavailable and unknown to postwar generations of biologists and administrators.

In 1935, Fauna No. 2, "Wildlife Management in the National Parks," was published, with a foreword by Director Arno B. Cammerer which stated that this second volume was a report "on the actual progress which has been made in wildlife administration (and wilderness-use techniques as they affect park biology) since the establishment of the Wildlife Division...it will serve as a guide to the park administrator in his effort to accomplish the purposes for which the national parks system was established."

This publication focussed on the details of problems and goals that had been outlined in the first Fauna, presenting them with a clarity of insight that startlingly parallels the pronouncements and stated goals of the '60s. For example, the Yellowstone elk problem was judged to be noticeably worse than in 1929 when the condition of the range had been judged "deplorable." Fauna No. 2 warned "the northern elk herd is hovering on the brink of disaster," and urged a herd reduction to 6000 animals through an annual slaughter of 3000 animals. An addition to Carlsbad Caverns to include McKittrick Canyon and the Guadalupe Mountains was proposed, and a plan for the establishment of research reserves, in response to the Director's request of June 6, 1933, was presented. Subsequently, 28 research reserves in 10 national parks and monuments were designated between 1933 and 1940, and were listed in *Ecology* (Kendeigh, 1942, pp. 236-238) but after the war there was little or no further action until the

recent '60s.

About half the time of the biological staff was spent on ecological reviews of proposed development projects; the other half was divided between wildlife management and research. Since administrative theory had not yet caught up with the young organization, the management and research activities were considered for practical purposes to be indistinguishable components of the total program for which each biologist was responsible.

Results

Some of the most important fruits of this early biological program were never widely visible because they involved elimination from CCC or related programs of ecologically destructive proposals before they could be activated. Prominent among the kinds of plans that were shelved because of their harmful biological consequences were proposals for certain new highways and truck trails into wilderness areas, control of various native animals because of their normal utilization of other park species, and the proposed elimination of sections of certain parks (in one case an entire National Monument) for administrative convenience.

More tangible were the Wildlife Division's professional reports and publications on the researches and surveys of its biologists. The writer lacks the time and facilities for compiling a list even of those reports that summarized the special investigations which were assigned by the Regional and Washington Offices to all these people--particularly since an administrative rule has for many years required that no such material be kept in park or central office files if it is more than three years old. However, the writer's own incomplete records indicate that, up to World War II, he produced at least 175 reports on special studies, many of them extensively documented by photos of habitat deterioration or recovery, and methods used to achieve improvements.

If the average number of special reports is reduced to 100 per biologist for the 7-year period referred to in order to be conservative, and then multiplied by 10, representing an estimated average number of Wildlife Division biologists on duty for the overall period, the toal of 1000 such reports appears reasonable. The routine monthly reports of the biologists are not included in this estimate. The Division's photographic collection stood at 2523 negatives when Fauna No. 1 was published (p. 6); it reached seven or eight thousand by World War II.

With respect to the Division's pre-war published articles, the present Office of Natural Sciences finds itself almost without records but it is known that Wright, Dixon, Thompson, Murie, King, McDougall, Borell and Bond were particularly active. (Cahalane was one of the most productive of all National Park Service biologists but the majority of his articles came out after the War, as did the writer's.)

It is also known that during 1936-7 alone, 76 such articles were published by Service personnel (Cahalane, Presnall and Beard, 1940, p. 345). For example, Ben Thompson's "History and Present Status of the Breeding Colonies of the White Pelican" (1933) summarized a study by the Division which was instigated by the controversy between fishermen and birdlovers as to whether the pelicans of Yellowstone were "harmful" or "beneficial." As a result of his findings, persecution of the Yellowstone pelicans was stopped.

The Wildlife Division also was able to persuade the CCC to construct wildlife range study enclosures and watering places in areas of specially critical need. A small number of these still survives.

George Wright's successful efforts on behalf of the trumpeter swan equalled--perhaps exceeded--his related achievement in establishing the Wildlife Division. Cahalane, Presnall and Beard summarized it well in their report of 1940:

"One of the most widely known achievements of the National Park Service, and one that has perhaps done more to influence public opinion toward conservation than any other single project of the Service, is the preservation of the trumpeter swans...It was early in 1930 that Mr. George Wright and his associates started active work to preserve these, the largest and rarest of all American waterfowl; and now, at the close of the decade, there is in operation a definite plan which gives every indication of assuring preservation to the swans. In 1930 there were but 2 known breeding pairs in Yellowstone National Park. Each incubated 6 eggs, yet there was only 1 cynet alive by late autumn. In the fall of 1931 there were known to be 5 breeding pairs, 10 birds not breeding, and 13 cygnets in the park. Others were known to be at the nearby Red Rock Lakes and in isolated parts of Canada, but Yellowstone was the only place offering complete protection.

"More rigid protection against illegal killing outside the park was essential, so Mr. Wright solicited the aid of local gun clubs and the cooperation of the Montana Fish and Game Commission. In 1933 that organization posted a $50 reward for apprehension of swan hunters. In spite of this reward, and the finding of 17 swans killed by shot, convictions proved difficult in the face of the common plea that the swans had been mistaken for geese. Since a majority of the few surviving swans were nesting outside the park on Red Rock Lakes, there seemed little hope of preserving the species unless these lakes could be made a refuge. Mr. J. N. Darling, then Chief of the Biological Survey, interested himself in the project at Mr. Wright's urgent request, and soon the active support of Secretary Ickes and the President was secured. On April 22, 1935, the Red Rock Lakes Migratory Waterfowl Refuge was established, and since that time the National Park Service and the Biological Survey have together taken a long stride toward preventing extermination of the trumpeter swans in the United States. Progress to date...reveals the slow,

natural rate of increase and the resultant necessity for great vigilance for many years to come. It is pertinent here to recall the following statement, made by George Wright in a letter dated May 2, 1934:

"'If and when the census ever reaches something like 500 breeding pairs in Wyoming, Montana, and Idaho, I think we will be justified in a real hope that this bird will be preserved for posterity.'"

The Fish and Wildlife Service estimated in 1966 that there were "about 700 in the contiguous United States and 1500 in Canada and Alaska" (Bureau of Sport Fisheries and Wildlife, 1966, p. B-5).

In looking back on the first five years of the Wildlife Division when George Wright was alive, it is apparent that, in addition to outlining goals, devising methods, and gaining acceptance within the parent organization, a remarkable number of significant and tangible results was achieved.

The Toes of Others

Ever since wildlife management became a profession it has been said that a wildlife management biologist's job consists primarily of managing not wildlife but people. If this requirement is any more widely recognized today than it was 30 years ago, today's school courses give little evidence of it. But history shows over and over that a brand new unit in an old-line organization has a special need for the soft approach when seeking to win acceptance for new ideas.

George Wright appreciated this by natural intuition, demonstrated by the rapid adoption of the far-reaching policy suggestions resulting from his wildlife survey (Fauna No. 1, pp. 147-8). But even George Wright was unable to make much progress--though he tried hard--in securing a relaxation of the traditional concepts which ignored the ecological role of native insect enemies of trees, and the ecological necessity of periodic light burning to maintain the fire-successional native trees and shrubs of the parks. Although he never seemed to let personal feelings of being in the right lead to a breakdown of cordial relations with those who thought otherwise, his staff of biologists--excellently trained in the new ecology, but not equally deeply schooled in the science of influencing people--sometimes fared less well. As long as Wright was in Washington to exert a reassuring influence at the top, hostility to the ecological approach was muted, and visible only in a few of the older parks.

Calamity

On February 25, 1936, George Wright and Roger Toll, Superintendent of Yellowstone National Park, were driving from El Paso to Tucson, as members of a joint international commission which had been studying the possibilities of establishing international

parks and wildlife refuges, including Big Bend, along the U.S.-Mexican boundary. National Park Service Regional Wildlife Technician W. B. McDougall, and Dr. W. B. Bell of the Bureau of Biological Survey (now Fish and Wildlife Service) were following in another car. A third vehicle was approaching from the opposite direction. Suddenly one of the rear tires of the approaching car blew out and it swerved directly into the path of the one driven by Superintendent Toll, killing him and George Wright.

Shock and grief among the many friends of these men, and in conservation organizations all over the country, was profound. Among the slowest to recover was the Wildlife Division, for this turned out to be the first of a series of blows which were destined to sap the morale and vigor of the group for the next 30 years. Perhaps fortunately, no one at the time could foresee the future circumstances in which George's unique gifts of persuasion would be desperately needed, so, after his death, the biologists continued for a while with their CCC project reviews, and their ecological research, about as before.

Victor H. Cahalane had been recruited in the Wildlife Division in 1934 and was stationed at Wind Cave before being transferred, in February 1935, to Washington to fill the position of Assistant Chief that had been vacated by Ben Thompson. After George Wright's death Vic became Chief of the Division, where he served with distinction until his resignation in 1955.

Vic Cahalane undoubtedly was the best qualified biologist in the Service for occupying this tragically vacated position. Up to 1948, when he was admitted to the Cosmos Club, he had produced some sixty articles and books more or less directly pertaining to national park wildlife, including his 682 page "Mammals of North America" (1947), which remains one of the most complete, authoritative and best written works on the subject today. His publications since 1948 have been equally voluminous and significant. He has served with distinction in various advisory posts including that of Adviser to the National Parks Board of Trustees of the Union of South Africa (1950-51), and both as Secretary and President of the Wildlife Society.

Vic pushed the Division's program vigorously, and perhaps he might have saved most of it, eventually, if World War II had not added its further disruption to the first grievous setback. But no one else had George Wright's ability to placate and win over the opposing school of thought which, increasingly, was coming to feel that biologists were impractical, were unaware that "parks are for people," and were a hindrance to large scale plans for park development.

By 1937 administrative sentiment in Yellowstone had reverted so strongly to coyote control to "preserve" antelope, mule deer, and bighorn, that biologist Adolph Murie was assigned to the park for a two-year ecological study. Murie's resulting report on "Ecology of the Coyote in the Yellowstone" (published in 1940 as NPS Fauna No. 4), upheld the Service's policy on the

protection of predators, was a major contribution to animal ecology, and became required reading in some university wildlife management courses. Nevertheless Murie's findings, and his personal concepts of ecological management of park resources, continued to be unpopular in various administrative circles until finally recognized by the Department in its Distinguished Service Award, made to him in July of 1965.

In 1938 Fauna No. 3, "Birds and Mammals of Mount McKinley National Park, Alaska," by Joseph Dixon, was published and its content was non-controversial. But in 1939 a national controversy boiled up over an increase in wolves and a decline in Dall sheep at McKinley. It looked as though certain influential sportsmen would get Congress to pass a bill requiring wolf control in the park, thereby threatening the Service's basic management policies. Adolph Murie was dispatched there for two years as a factfinding, biological troubleshooter. His resulting report, "The Wolves of Mount McKinley" (Fauna No. 5, 1944), presented the biological facts so effectively that pressure for wolf control subsided. His work became, and still is, a classic in the literature of vertebrate ecology and wildlife management, and like his previous one, was required reading in many university classes. But as outside observers have pointed out over the years, the Service's biological program, faced with mounting ecological problems, attacks, a dwindling staff (by 1939 it had been reduced to nine men, four paid from regular funds and five from CCC funds), and an inadequate budget, gradually found itself reduced, particularly after the War, to essentially a troubleshooting operation.

Also in 1939, in accordance with a Departmental reorganization program initiated by President Roosevelt, the entire National Park Service Wildlife Division was transferred to the Fish and Wildlife Service. All of the Division's positions and duty stations remained unchanged except that the unit now was called an "Office of National Park Wildlife" in the Fish and Wildlife Service, and the biologists reported to supervisors of that agency instead of to the Park Service. Even the CCC funds for operation of the Division continued to come from the National Park Service, by transfer. However, there can be no doubt that if any feelings had been developing among oldtime members of the latter organization, that wildlife biologists were an essential part of the National Park Service family and programs, such feelings were diluted by this involuntary transfer to another agency.

Additionally, the climate in Congress had grown so increasingly unfavorable to the concept of research that this word was dropped, in 1939, from the Branch of Research and Education--which had just lost the above-mentioned Division anyway.

World War II

During the first few years after George Wright's death, the continuing momentum of projects already underway largely over-

shadowed a vague, disquieting impression that the needs of the biological program were not receiving the same understanding and support at the highest levels that they once had. Working for the Fish and Wildlife Service was no strain, for that agency let the program continue as before. In fact one happy result of the merger was the interbureau preparation during this period of the book "Fading Trails" (Beard et al. 1942), a beautifully written and illustrated forerunner of today's "Rare and Endangered Fish and Wildlife of the United States" issued by the Bureau of Sport Fisheries and Wildlife (1966).

But about the time "Fading Trails" was ready for the printer, Pearl Harbor cut the Division down to a vestige. The CCC was abolished within a year, eliminating the National Park Service's principal source of funds. All of the Division's biologists were separated, or transferred back to Park Service activities which were considered more vital to the war effort than biology, with the exception of Vic Cahalane, Joe Dixon, and Adolph Murie whose biological work continued to be supported by Park Service funds. The war ended an era. Murie's previously mentioned Fauna No. 5, "The Wolves of Mount McKinley," marked the last of the Service's Faunas for the next 17 years; no further orientation and planning meetings of Service biologists were held for 15 years; restoration to prewar staffing strength was deferred for 25 years.

Post War Eclipse

After the war the Fish and Wildlife Service did not again receive funds for the reactivation of an Office of National Park Wildlife. Instead the Park Service reestablished eight biologist positions under the Division of Interpretation, which was the lineal descendant of the old Branch of Research and Education.

But, as previously mentioned, that parent organization had experienced its own deemphasis of research. When the naturalist staffs were restored to prewar status, the research activities of park naturalists in the earlier years--illustrated by the geological research of Edwin McKee at Grand Canyon, the work of Arthur Stupka at Great Smoky Mountains, Frank Brockman at Rainier, and the still earlier work of Milton Skinner at Yellowstone--were discouraged by the press of new administrative and planning duties; emphasis was focussed more on the communication of existing knowledge than on the time-consuming search for new information.

Vic Cahalane continued his struggle to present the ecological justification for restoring prewar support to biological research and management. And on February 10, 1945, the Service issued a statement on "Research in the National Park System, and its Relation to Private Research and the Work of Research Foundations." Its recommendations covered history and archeology as well as the biological resources and advocated a research program to provide a continuous flow of ecological knowledge essential for interpretation and management. An adequate staff of

biologists was recommended. A list of 77 needed biological programs was included, with priorities.

Interest in man's own activities of conquest and struggle has preceded by centuries an interest in understanding and protecting the natural environment on which he depends for his future survival. For this reason, the Service's archeology and history programs recovered from wartime setbacks in a few years and expanded beyond previous levels. But with biology, as the National Academy of Sciences pointed out (1963, p. 27), "The number of biologists was not restored to prewar strength despite the increasing pressures on park resources; a situation experienced by no other professional group within the National Park Service except the geologists...The years passed--but little happened."

It is unnecessary to recapitulate in detail here the frustrations and roadblocks in the period of eclipse for biology which lasted from 1942 to 1963. This situation is now a matter of record and beyond further serious argument. It was briefly outlined in the National Academy's report, which is recent, familiar to most, and readily available. If it were necessary to further substantiate the case made by the Academy it could be readily done by reference to numerous statements made and actions taken in past years--but particularly to the recommendations on which action was not taken--which are recorded in the files.

However, the important fact today is that an increased awareness and concern over biological resource deterioration in the parks has been awakened, and positive steps are being taken to fulfill the Service's responsibilities for restoring and managing these unique resources.

In order not to leave a gap in the continuity of this account it will be merely mentioned without elaboration that in 1955 Vic Cahalane resigned in frustration as Chief, feeling biology had been too long ignored when plans for Mission 66 included no positive program for biology's resurrection. Gordon Fredine, his able successor, worked long and hard for such a restoration, but his recommendation for a substantial increase in the biological staff led some to feel that such a plan was being pushed too far, and the 1958 reorganization of biology into the two administratively separate activities of research and management was carried out instead.

Nevertheless Fredine did manage to secure the establishment, in 1957, of a new Aquatic Biologist position in the Washington Office. This was (and still is) the only position since David Madsen's in the '30s with full-time responsibility for the fishery resources of the System. The new position was filled by Orthello L. Wallis whose three-year fishery management studies at Yosemite, summarized in a 294-page report, had set new standards within the Service for fishery research and management.

Meanwhile, pressure from the outside was exerted on the Service, from time to time, to strengthen its biological program.

This pressure increased in the middle and late '50s as the application of pesticides against native forest insects came under increasing question by outside organizations, particularly the Sierra Club and National Parks Association. In 1959, Dr. Stanley A. Cain, then Chairman of the Department of Conservation at the University of Michigan, told the Sixth Biennial Wilderness Conference that, "the National Park Service does not have a program of basic ecological research...(what is being done)...fails to approach at all closely to the fundamental need of the Service itself...(and) the Service is missing a bet by not having an adequate natural history (ecological) research program."

Dr. Cain's appraisal appeared to arouse more than the usual degree of interest on the part of the Service, and perhaps the Department as well. It marked the first sign of which Service biologists such as the writer were aware of Dr. Cain's interest and concern--and increasing personal involvement--in this situation. Other well-wishers on the outside, including the Secretary's Advisory Board on National Parks, Historic Sites, Buildings and Monuments, were adding their recommendations during this period for a more effective research program.

As a result of this and other encouragement, the Service in 1958 obtained its first official research budget as such--$28,000 for the entire System. But even this small sum had a remarkable psychological as well as a fiscal pump-priming effect. Several of the Regional Offices, and even a few parks, materially augmented this initial sum with allocations from their own funds. This stimulated research institutions and scientific collaborators to produce for the Service, by 1962, several dozen manuscript reports on critical ecological situations.

In 1961 the Service revived its long-dormant Fauna Series with No. 6, "The Bighorn of Death Valley," the most original and comprehensive publication on this species to date, and one which summarizes an ecological research project that was partially financed from the Service's meager annual research budget.

Meanwhile, in the parklands themselves, biological time-bombs had gone on ticking through all the years of inattention. Now giant sequoias were leaning and falling with attention-catching frequency and people were asking why, fears were being expressed that DDT was becoming an ever greater biological hazard, that the saguaros of Saguaro National Monument were vanishing, that Yosemite Valley was becoming choked beyond recognition by an unnatural and hazardous invasion of trees, that feral goats threatened the survival of unique vegetation in the national parks of Hawaii, and that Everglades National Park was dying of thirst. Above all, the fifty-year old, infrequently-faced-up-to problem of the Yellowstone elk was about to come back again into public view, its ecological aspects worse than ever.

Better Days

The Department had for some time been increasingly aware of these developments. As a result, Secretary Udall took several

steps in 1961 and 1962 to secure the best and most objective outside appraisals and recommendations for correcting the various situations:

He induced the Old Dominion Foundation to provide the Conservation Foundation of New York with funds for a study of the effects of increasing human use of the parks on flora and fauna, and the current ecological health of the major units of the System--this was in effect a follow-up appraisal of where the parks seem to be headed thirty years after the initial survey by George Wright's team.

The Conservation Foundation's two-man survey team consisted of Dr. F. Fraser Darling, who is Vice President of the Foundation and an internationally known ecological consultant to governments of Africa and elsewhere, and Noel D. Eichhorn, Associate. Their park-by-park survey commenced in 1962 and terminated in 1965. Publication of their findings and recommendations in book form was contemplated but has not yet (1967) taken place. However a cogently expressed Interim Report has been transmitted to the Department and to the Service, though not distributed, and an equally specific Final Report is nearly complete.

The Secretary requested two other surveys during this period, the results of which have been so far-reaching, and in the case of the first one so widely distributed and quoted, that they need no review here except to indicate their place in the continuity of events. The first of these was the Advisory Board on Wildlife Management report on "Wildlife Management in the National Parks," appropriately chairmanned by Dr. A. Starker Leopold, which independently reached the same conclusions as the long-forgotten Fauna No. 1, presented a parallel program of management recommendations, and on every count deserved its status as the "bible" of today's National Park Service research and management biologists, and administrators.

The second survey was the one by the National Academy of Sciences* so frequently referred to in the present history. Much credit for tireless efforts on behalf of research which eventually led to this latter survey, and finally to research budget increases, belongs to Howard Stagner, who took over responsibility for the biological research program from Gordon Fredine in 1960, and, first as Chief Naturalist later as Assistant Director, won increased recognition for the importance of the research function. [*Dr. Stanley Cain was a member of both of these study groups; Dr. F. Fraser Darling was a member of the second.]

On February 4, 1963, the number of research biologists was restored to eight--the highest since the reorganization of 1958--with the addition to the WASO staff of Dr. Robert M. Linn from Isle Royale. He was the first plant ecologist among Service biologists since Dr. W. B. McDougall. Meanwhile management biologists in the expanding Division of Ranger Activities had reached a total of 15 or more.

In December 1963, as a result of another reorganization, Ben

Thompson who had long been in charge of the Service's program of new park establishment, was made Assistant Director of Resource Studies (Research). He redoubled the efforts of the staff to justify an increase in the research budget. In 1964 several years of intense research budget-justifying were rewarded by an increase from the previous $29,000 to approximately $80,000 for financing research projects. Though still laughably small in the eyes of scientists on the outside, the pump-priming effects of this increase made possible a total of 47 research projects for 1964 that were wholly or partly financed by the Service (Linn, 1965).

In May 1964, in conformance with the Wildlife Management Committee's and the National Academy's reports, and the specific recommendations of influential scientific advisors in and outside of the Department, Dr. George Sprugel, Jr. was appointed Chief Scientist of the new reorganized Division of Natural Science Studies. He was to be "responsible for the overall formulation and staff direction of a Servicewide natural history study program (research)..."

George Sprugel had been Program Director for research in Environmental Biology at the National Science Foundation and had a thoroughly professional understanding as to the magnitude of the funding that would be required to raise the operating level of the Service's research program to a point where it could adequately cope with the biological problems that had gotten out of hand. He shared the view of the National Academy that the Service's annual research program, to be adequate, should total in the millions. He considered that the low level of staffing and funding which he had inherited was deplorable and he accepted the appointment on the understanding that a substantial improvement would be quickly forthcoming.

With characteristic energy, Sprugel organized WASO and park biologist and naturalist staffs, and panels of nationally prominent natural science authorities, into study teams which met in the parks to survey the ecological problems there. From on-the-spot information so obtained, the teams then formulated Natural Sciences Research Plans tailored for each park which outlined the research needed to adequately inventory and appraise the condition of the natural resources, and to provide the information required by management to restore and protect that particular park.

In December 1964, Ben Thompson retired from the Service after a year of strenuous but comparatively unrewarding effort to get biology into high gear. Howard Stagner took his place, the efforts were continued and were rewarded by further gradual progress.

In February 1965, a Natural Sciences Advisory Committee, which actually had been appointed in 1964, met and issued a warning against research "being treated as an unimportant fringe activity." The committee members were Dr. Cain, Sigurd Olson, and Dr. Leopold, Chairman.

On May 24, 1965, Dr. Cain became Assistant Secretary of the Interior for Fish and Wildlife, and soon thereafter for National Parks as well. Not long afterward, native forest insects were recognized in official statements by the Service as having as much right to existence in the parks as other native fauna, except under special local conditions. The ecological role of naturally-caused fire also was officially recognized.

In 1965 WASO funds for research projects totalled $105,500, making it possible to support continuing investigations on a more adequate scale as well as to undertake a few new ones. As in the case of other destructive overpopulations of ungulates in recent years, the Service identified and took corrective action on the Yosemite deer surplus despite the uninformed, adverse reaction of a minority of the public.

The health and vigor of programs, like that of people, sometimes passes through a low point shortly before the period of recovery. The year 1966 seemed to be in that category for the Service's biological program. The Yellowstone elk situation was still boiling and the Yosemite deer control program was under fire; Everglades was being called a national disaster, and the forest insect control program at Grand Teton was under sharp attack. Articles criticizing the inadequacy of the Service's biological program appeared in *BioScience,* and George Sprugel resigned, feeling biology was not receiving the understanding and support he had been led to expect.

Nevertheless there were gains in 1966 too: The research project budget was approximately $177,000 which made possible the support of a significant number of new projects in addition to the completion of some of the older ones.

Fauna No. 7, "The Wolves of Isle Royale," appeared in 1966 as another landmark in this distinguished life history and ecological series. Three of the Division's comprehensive Natural Sciences Research Plans, covering Isle Royale, Sequoia-Kings Canyon, and Everglades National Parks, were duplicated by offset process and became worthy, up-to-date successors--scientific contributions in their own right--to the early ecological inventories, analyses, and action program proposals of Faunas No. 1 and 2.

Also in this year the Grand Teton beetle control program was reduced in accordance with a plan which included phasing it out entirely in 1967. A biologist position--filled by James K. Baker--was established with responsibility for easing the long-standing critical conditions at Death Valley, Joshua Tree, and Channel Islands. A similar position was established for Crater Lake, Lassen and Lava Beds, and filled by Richard M. Brown.

Walter H. Kittams, veteran of a 20-year struggle on behalf of park biology, received a new and promising assignment at Carlsbad Caverns with responsibility for Guadalupe Mountains, Big Bend, and other National Park areas. William B. Robertson, veteran of long-troubled Everglades, received significantly in-

creased recognition and a badly needed assistant. Other large-scale help for Everglades also was on the way.

Maurice Sullivan of NCR--in the '30s a member of the Wildlife Division--was taken back into the fold; L. Kay Thomas, also of NCR and another recruit into the minority group of Service botanists, joined the Division and was sent to Duke University at government expense to further broaden his professional background.

The Natural Sciences Advisory Committee met with the Director and others at Grand Teton in September 1966, and commended the Service on the substantial progress it had made since the Committee's previous meeting of February 1965, "in establishing a framework of organization, planning and operating procedures; in focussing effort upon field problems; and in the development of a favorable climate within the Service for the conduct of Natural Science research." (Dr. Charles E. Olmsted, distinguished botanist and conservationist, had been appointed to the vacancy that resulted when Dr. Cain became Assistant Secretary).

A further vigorous program was proposed by the Committee "to place one or more field research personnel...in each of the natural areas of the System...to secure an adequate budget...to fill certain vacancies in other activities with research personnel, and to assign these personnel to field areas as research biologists--to engage the active participation of universities and other research institutions in the research program of the National Park Service."

Recovery--Full Circle

Ever since the appointment of the Natural Sciences Advisory Committee in 1964, evidence of its effectiveness in securing increased understanding for biology had been accumulating. By 1967 the results of this and other encouragements, together with the pressures from various sources, indicated that 1967 did indeed signal the end of a period of stagnation and the beginning of a new period of opportunity and hope. Thus the year 1967 resembled in its bright outlook the year 1936. And though many ecological situations in the parks had in the meantime grown more severe, there was in 1967 a more widely distributed appreciation of the ecological values at stake. Moreover, following 30 years of evolution and development within the field of Ecology itself, the biological staff of 1967 had the advantage of better training and a more advanced technology than the staff of the '30s.

Another reorganization led to the replacement, in January, of the Division of Natural Sciences by a new Office of Natural Sciences reporting to the Director. This was what the National Academy had recommended in its 1964 report. Bob Linn, who since Sprugel's resignation had been in charge of the daily operations of the research organization, and much of its long-range planning as well, was given this permanent responsibility as Deputy Chief of the new Office. Dr. Starker Leopold accepted

the position of Chief, WAE, while retaining his regular position, responsibilities and location at the University of California. The effect of these moves by the Service was to further strengthen, formalize, and officially support the key roles that both of these men had been playing in the revitalization of the biological program.

As this summary of events comes to a close, additional encouraging events are taking place. Glen Cole's outstanding success in the Teton elk research and management program, and in training top quality biologists, is leading to his promotion to still wider fields of responsibility which will include guidance of the comparable programs of Yellowstone and Glacier in addition to the one at Teton. A new and vigorous generation of biologists, including James W. Larson, Stephen D. Viers, William H. Hendrickson, Warren F. Steenbergh, Garrett Smathers, William J. Barmore, as well as others previously mentioned, has joined the revitalized organization. The Alaska biological program has been strengthened by the assignment there of Richard G. Prasil from the San Francisco Regional Office.

Of great significance is an informal, non-reorganizational move toward closer understanding and identification of objectives between the management and research divisions of NPS biology than has existed since they were sundered by the reorganization of 1958. In large measure this long desired objective now seems attainable because new and younger people have had the benefit of modern schooling which increasingly emphasizes the ecological approach.

The Future

In summary, the Service's program to rescue and restore the unique biological resources which are "the very foundation upon which the National Park Service is built," is back in high gear. But it is not enough to raise the level of achievements to what it was in the '30s. Since those days the biological clock has kept on ticking and for some park situations the time for rescue has nearly run out.

The Office of Natural Science Studies has inherited a sound program from its ancestor, the Wildlife Division. This program has been endorsed, restated, and supported by the highest authorities in the country, and now is being directly inspired and guided by some of them. Today's staff is better trained than ever; ecological understanding is less and less confined to professional circles and increasingly is entering into administrative considerations.

So far the stage for actual recovery has only been set. An enormous amount of work, extending over many years, must be done to accomplish the goals of restoration and maintenance that have been established. But it is clear that the tools and the know-how are at hand, or can be obtained.

It is also clear that another recession like the last would

bring irreversible ecological destruction to many of the national parks. To save these world-famous treasures we must learn this lesson from history.

NATIONAL PARK SERVICE BIOLOGISTS IN THE PRE-WORLD WAR II ERA

Most of the names listed below are marked with an asterisk (*), which denotes that they appeared on a mimeographed routing sheet that was used shortly before World War II by the Washington Office of the Wildlife Division in circulating the monthly reports of its biologists--the same as we have commenced to do again in 1967. The routing sheet shows that at the time of its preparation there were 21 of these biologists in the field (some stationed in parks, others in or adjacent to CCC camps which conducted operations in the park, some in regional offices)--plus an estimated three (not marked with an *) in the Washington Office.

Owing to cutbacks in staffing which had commenced before this particular routing sheet was used (as well as certain replacements), it does not show the names of all the Service biologists of that period. Accordingly, the writer has added as many of the latter as he could remember, or find in other records, to make the historical record more complete. He has also indicated what he knows, or was able to learn from others, concerning the 1967 status of all.

NAME	PRE-WAR DUTY STATION	1967 STATUS (WHERE KNOWN)
*H. P. K. Agersborg	Richmond, Virginia	Deceased ?
*Daniel B. Beard	South Miami, Florida	Santa Fe, New Mexico; Regional Director, NPS
*R. M. Bond	Portland, Oregon	St. Croix, Virgin Islands; US Department of Agriculture Experiment Station
*A. E. Borell	Santa Fe, New Mexico	Denver, Colorado; retired from Soil Conservation Service
*Ashley C. Browne	San Francisco, CA	Retired from Agriculture Experiment Station, Hawaii ?
Victor H. Cahalane	Washington, DC	Clarksville, NY; retired from NY State Museum
*David Damon	Custer State Park, SD	USFS, Melrose, MA ?
William B. Davis	Yellowstone NP	Texas; retired from Texas A&M
*L. M. Dickerson	Oklahoma City, OK	Retired from Soil Conservation Service; deceased
*Joseph S. Dixon	San Francisco, CA	Retired from NPS; deceased 1952
Fred H. Dale	Glacier NP	Patuxent, MD, Fish and Wildlife Service
*W. S. Feeney	Des Plaines, IL	?
Raymond Fleetwood	?	Brazoria National Wildlife Refuge, Texas, Fish and Wildlife Service

*Russell K. Grater	Denver, Colorado	Sequoia-Kings Canyon National Parks, Chief Park Naturalist
*H. E. Hart	Omaha, Nebraska	?
*H. A. Hockbaum	Mariemont, Ohio	Waterfowl Research Station, Delta, Manitoba, Canada
*W. J. Howard	Richmond, Virginia	Deceased
*H. M. Jennison	Great Smoky Mountains NP	Deceased
*Maynard S. Johnson	Boston, Massachusetts	Deceased ?
L. Floyd Keller	Zion National Park	Resigned from NPS
*Willis King	Great Smoky Mountains NP	Washington, DC, Fish and Wildlife Service
David Madsen	Salt Lake City, Utah	Deceased ?
*W. B. McDougall	Santa Few, New Mexico	c/o Museum of Northern Arizona; retired from NPS
Harlow B. Mills	Yellowstone NP	Retired from Illinois Natural History Survey
*Adolph Murie	Omaha, Nebraska	Moose, Wyoming; retired from NPS
*Fred Mutchler	Atlanta, Georgia	?
Robert T. Orr	San Francisco, CA	California Academy of Sciences
Fred M. Packard	Rocky Mountain NP	Washington, DC, Office of International Affairs, NPS
Clifford C. Presnall	Washington, DC	Colespoint, Virginia; retired from Fish and Wildlife Service
Charles Quaintance	--	Harvard University ?
Dwight Smiley	San Francisco, CA	?
James O. Stevenson	Washington, DC	Washington, DC; Fish and Wildlife Service
Arthur Stupka	Great Smoky Mountains NP	Gatlinburg, Tennessee; retired from NPS
Maurice Sullivan	Acadia NP	Washington, DC, NCR, NPS
*Lowell Sumner	San Francisco, CA	Friendship, Maine; retired from NPS
*O. B. Taylor	Richmond, Virginia	Deceased
Ben H. Thompson	Washington, DC	Washington, DC, National Conference on State Parks
George M. Wright	Washington, DC	Deceased

References Cited

Adams, Charles C. 1906. An ecological survey in Northern Michigan: a report from the University Museum, University of Michigan. Michigan State Board of Geological Survey, Report, 1905.

Adams, Charles C. 1908. An ecological survey of Isle Royale, Lake Superior. Michigan State Biological Survey, 1908.

Advisory Board on Wildlife Management. 1963. Wildlife management in the National Parks. A. Starker Leopold, Chairman. Department of the Interior. 23pp.

Beard, Daniel B., Frederick C. Lincoln, Victor H. Cahalane, Hartley H. T. Jackson, and Ben H. Thompson. 1942. Fading trails, the story of endangered American wildlife. ed. by Charles Elliott. The Macmillan Co. xv + 279 pp. Illustrated by Walter Weber.

Bureau of Sport Fisheries and Wildlife. 1966. Rare and endangered fish and wildlife of the United States. Resource Publication 34. Washington, U. S. Government Printing Office. [Pages not consecutive.]

Cahalane, Victor H. 1947. Mammals of North America. New York, the Macmillan Co. x + 682 pp.

Cahalane, Victor H., Clifford C. Presnall, and Daniel B. Beard. 1940. Wildlife conservation in areas administered by the National Park Service, 1930-1939. A report to the Special Committee of the U. S. Senate on the Conservation of Wildlife Resources. pp. 347-380 in The Status of Wildlife in the United States. Washington, U. S. Government Printing Office. 457 pp.

Cain, Stanley A. 1959. Ecological islands as natural laboratories, pp. 18-29, in The Meaning of Wilderness to Science. Sixth Biennial Wilderness Conference, Sierra Club, San Francisco.

Dixon, Joseph S. 1938. Birds and mammals of Mt. McKinley National Park, Alaska. Fauna Series No. 3. Washington, U. S. Government Printing Office. xii + 236 pp.

Grinnell, Joseph, Joseph S. Dixon and Jean M. Linsdale. 1930. Vertebrate natural history of a section of Northern California through the Lassen Peak region. Berkeley, University of California Press. v + 594 pp., 181 figs. in text.

Grinnell, Joseph and Jean M. Linsdale. 1936. Vertebrate animals of Point Lobos Reserve, 1934-35. Carnegie Inst. of Wash., Publication No. 481. vi + 159 pp., 39 pls., 1 fig. in text.

Grinnell, Joseph and Tracy I. Storer. 1924. Animal life in the Yosemite. Berkeley, University of California Press. xviii + 741 pp., 60 pls., 65 figs., 2 maps.

Kendeigh, S. Charles. 1942. Research areas in the National Parks, January 1942. Ecology 23:236-238.

Leopold, Aldo. 1933. Game management. New York, Chas. Scribner's Sons. 481 pp. (reprinted in 1947).

Leopold, Aldo. 1949. A sand county almanac. New York, Oxford University Press. 226 pp.

Linn, Robert M. 1965. List of natural science research projects in the National Park System funded by National Park Service and all other sources during 1964. 30 pp.

Mech, David L. 1966. The wolves of Isle Royale. Fauna Series No. 7. Washington, U. S. Government Printing Office. xiii + 210 pp.

Murie, Adolph. 1940. Ecology of the coyote in the Yellowstone. Fauna Series No. 4. Washington, U. S. Government Printing Office. x + 206 pp.

Murie, Adolph. 1944. The wolves of Mt. McKinley. Fauna Series No. 5. Washington, U. S. Government Printing Office. xix + 238 pp.

National Academy of Sciences. 1963. A report by the Advisory Committee to the National Park Service on Research. William J. Robbins, Chairman. National Academy of Sciences - National Research Council. xi + 156 pp.

National Park Service. 1943. Wildlife conditions in the national parks, 1941. National Park Service. 58 pp.

Thompson, Ben H. 1933. History and present status of the breeding colonies of the white pelican in the United States. Occasional Paper No. 1, Contribution of Wildlife Division. 83 pp.

Welles, Ralph E. and Florence B. Welles. 1961. The bighorn of Death Valley. Fauna Series No. 6. Washington, U. S. Government Printing Office. xv + 242 pp.

Wright, George M., Joseph S. Dixon and Ben H. Thompson. 1933. A preliminary survey of faunal relations in national parks. Fauna Series No. 1. Washington, U. S. Government Printing Office. iv + 157 pp., 56 figs. in text.

Wright, George M., and Ben H. Thompson. 1935. Wildlife management in the national parks. Fauna Series No. 2. Washington, U. S. Government Printing Office. viii + 142 pp., 61 figs. in text.

Lowell Sumner, Principal Research Biologist, National Park Service [retired], Glenwood, New Mexico.