Trends

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Trends in Natural Resource Management

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Introduction

Natural resource management is a field so diverse that it touches everything from pelicans to people, and how they relate to the environment and to one another. A good manager must master the art of matching present day human needs with the requirement to preserve natural resources for future generations.

James Patterson, author of the article in this issue on "Urban Wastes for Soil Rejuvenation," notes that "One of the constant battles all park administrators must face is that while trying to practice conservation of a natural resource, parks are continually becoming the focal point for record visitation; thus, the natural resource often receives the heaviest impact. Clearly, if some restraints are not imposed, constant use will lead to a degradation of the very resource the park celebrates by its existence."

In a nutshell, Patterson has captured the essence of the dilemma, one which is addressed in varying degrees by articles included in this issue. Much of what has transpired in natural resource management is a result of federal legislation, making natural resource protection a mandate for all Americans. Despite these precautions, some of which have come too late to undo — damage already inflicted on our natural resources — the battle continues. Indeed, portions of our nation's heritage have been captured, even within our National Park System.

In retrospect, and benefitting from the hindsight of scientific research, many of our finest national parks have not received adequate protection. Such large and famous parks as Everglades, Glacier, and Redwood, are threatened by adverse external, as well as internal, environmental and resource management problems. Threats vital to park resources at the federal, state and local level arise from land development efforts, water diversion, logging, power plant construction, industry, and a wide range of activities which take place beyond park boundaries.

By the same token, park natural resources may be harmed by influences originating from within the park. Such things as incompatible visitor use, or resources overuse, park management activities, incompatible resource uses, or a variety of natural and accidental phenomena may actually harm the environment.

What are some of the things a manager has to contend with in terms of controlling harmful influences within a park? The articles in this issue touch on fire management, water management, fishing rights, the proliferation of pests, the need to protect endangered and threatened species, the problem of overlapping and sometimes conflicting uses of land areas within a park, and the need to keep tabs on backcountry uses.

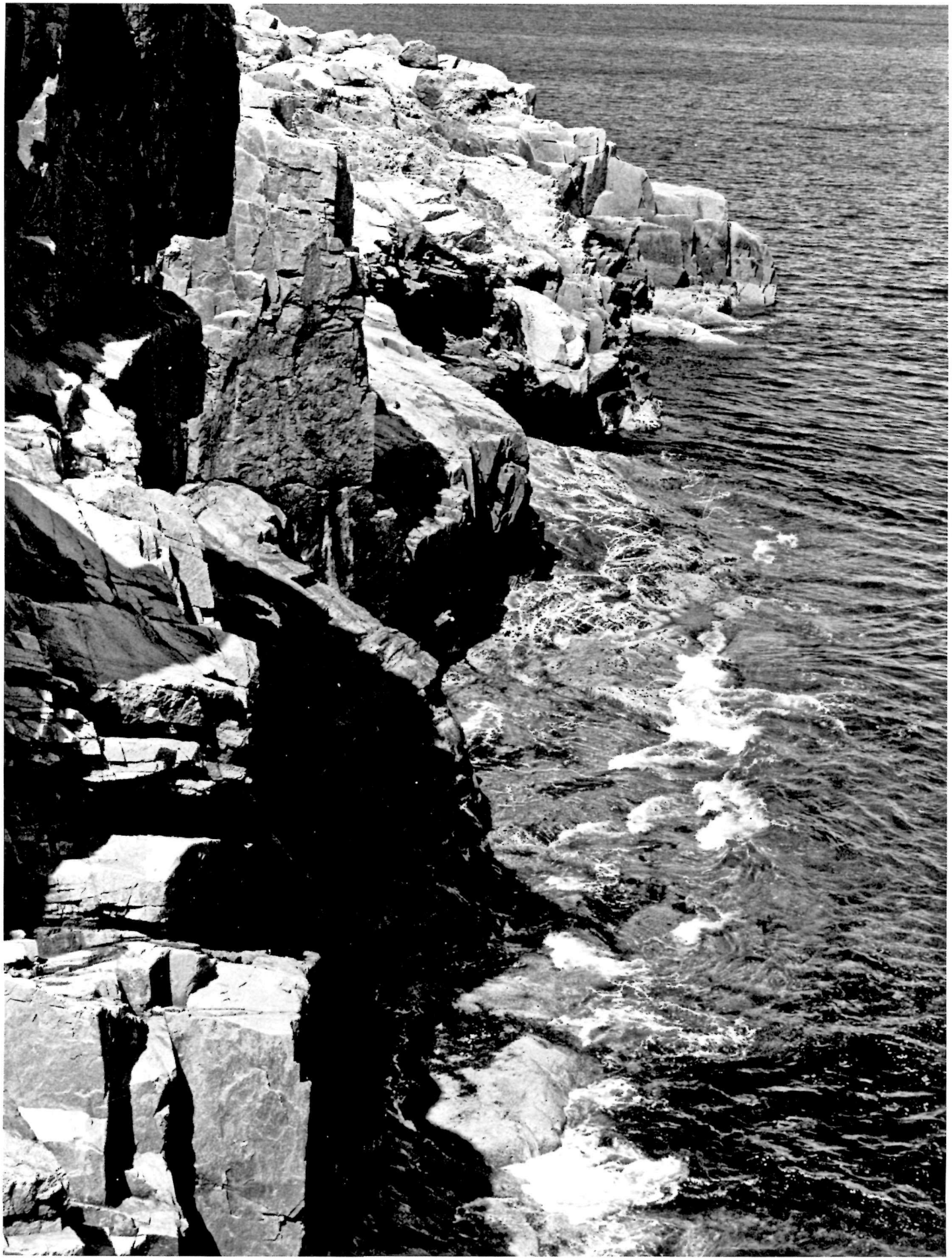
Wildlife management, fire management, and the control of introduced plants and animals are typical examples of important resource management programs, which may prove to be controversial for a park manager. Following the highly effective predator control programs of the 1930's and '40's, ungulate populations soared out of control. Population reduction measures for games species have not been popular with hunters. Similarly, proposed burro reduction programs have been opposed by school children and by the humane society, but generally endorsed by conservation organizations. The "Smokey the Bear" program, which one might think was a completely successful effort, has in fact been responsible in large part for conditioning the public against the acceptance of fire as a natural phenomenon in the shaping of natural landscapes. Thus, the National Park Service has launched a major interpretive program with other federal agencies, to help explain the role of natural fire management. The interpretive effort is touched on briefly in the article in this issue on the natural fire experience at Yellowstone National Park.

All of this information serves to highlight the fact that resource management programs must be based on the best possible information and knowledge on a broad range of topics. Using this knowledge, an affirmative plan of action must be developed and followed. Ideally, implemented management plans should be carefully monitored for effectiveness. To make a plan work, public participation and involvement is necessary — that means good interpretive programs, and land managers with an ability to communicate their understanding of the problems of natural resource management to the layman. Good research, along with a continuing education program for both staff and visitors, is necessary to maintain a quality natural resource management plan.

The ultimate goal must be kept in mind at all times — natural resource planning and management means the preservation of a resource while at the same time maintaining optimum levels of visitor enjoyment and appreciation.

Armed with a complete understanding of the resources and their potential, as well as their weaknesses, innovative planning and development can provide for a full range of visitor enjoyment without jeopardizing our natural resources.

Neal Guse, Chief, Natural Resources Management Division, National Park Service, and staff



Planning for Natural Resources

by David Butts

The basic concept behind the establishment of most parks is the preservation of natural resources for the enjoyment of people. All too often, however, park managers get so caught up in meeting visitor needs that they lose sight of the important considerations necessary to preserve the natural resources of their parks.

To develop a plan for the preservation and maintenance of the resources of any park, it is first necessary to assess just what is there. At least, a listing of plants and animals (including some idea of population levels if possible) is necessary. Making an inventory is not the easiest task in the world. Trained consultants are available for this job if a budget permits, if not, volunteers can be solicited from local wildlife groups, college and university departments of zoology and botany, or local zoos.

Many state and federal agencies have personnel to help catalog certain resources. At least, an inventory of park resources should include what might best be termed "management ecosystems," that is, broad categories which might well include several different ecosystems, for example, aquatic ecosystems incorporating lakes and streams, etc., which are related in terms of management operations and problems.

Aside from helping to develop a plan for the management of these resources, this inventory is an invaluable tool for the development of interpretive programs within the park.

Developing a Plan

In order to develop a plan, a park manager must have a grasp of the interrelationships of resources within his park and on its boundaries. Any plan is at best an expression of the essential balancing act which all park managers face — making a natural area meet today's needs while preserving that area for future generations as well.

Once a survey has been completed, constant monitoring of the situation is necessary to keep the plan fluid, and responsive to changes as they occur.

For example, intermittent or infrequent resource needs such as insect outbreaks are commonly omitted from plans unless they are at their peak when the

plan is developed. Knowing the resources of the park and their characteristic behavior enables a park manager to respond appropriately to a situation. Forests prone to have beetle outbreaks, for example, need to be monitored so that prompt effective action can be taken. If a manager only responds to this situation in isolation, as it were, then park operations can quickly degenerate into a "management by crisis" approach in which little lead time can be provided to correct vegetative or wildlife changes before irreversible losses occur.

The size of a park and the complexity of influences on its resources dictate the level of detail required in a plan. Some parks can treat the topic of "wildlife" in a page — others may find that the heart of their plan revolves around management approaches to wildlife. Disease carriers, such as ticks, fleas and mosquitoes should also be addressed, as well as rodents and other small animals.

A plan should incorporate the full spectrum of management options with those resources. Properly pre-planned, the operational program should flow smoothly, reflecting the laws, policies and guidelines of the responsible agency and any state and federal regulations that might apply. Visitor use patterns and changes in the ecosystems within the park may shift and cause a plan to shift. It is important that any plan be developed so that a park manager can make changes, not in response to crisis situations alone, but also in response to emerging long-range patterns.

To give readers a better idea of the detail and type of information required for a well-executed resource plan, several excerpts are presented below. It should be noted that references to maintenance and research functions are, in many park operations, interchangeable.

Wildlife

"Manage native animals as healthy, self-supporting populations:

1. Minimize bear/human relationships and conflicts.
   a. Eliminate the availability of unnatural foods.
   b. Educate the visitors and the park and concession employees about the problem, cause and solution.
   c. Enforce special regulations on proper food storage as circumstances warrant . . . ."

"Census ground squirrel populations and reduce populations in developed areas as necessary.

A method of ground squirrel population census will be developed to show annual population differences in a given area and comparison between populations in developed areas (e.g., campgrounds) and populations in comparable habitat in undeveloped areas. When reduction is deemed necessary by reason of an identified problem such as the presence of plague in developed areas, burrows will be treated with an approved rodenticide and insecticide. Treatment should insure that contact will be limited to target pests. . . ."

taken from plans developed by Sequoia National Park

Trees

"Hazardous Trees in High Visitor Use Areas

For various reasons — particularly Dutch Elm disease, lightning strikes, and aging — trees are falling or losing limbs during periods of wind, rain and ice. These trees present a hazard to park visitors.

Action (Continued Maintenance)

Routine maintenance of trees and other vegetation is provided by the park staff. Damaged or diseased trees are removed to prevent further deterioration. When facilities not available to park staff are required, the work will be contracted by professionals . . ."

taken from plans developed by Pea Ridge Nat'l Military Park

"Continue a program of tree hazard abatement within approximately 6,000 acres (2,400 ha) of campgrounds, roadsides, and other developments:

1. A standard rating system to assign priority removal values to tree and limb hazards is applied to all development and road units. Priority assignments are reviewed within each unit at least once every five years.
2. Hazard removal is done in each unit according to priority value following the guidelines listed below:
   a. All trees are removed in a manner which minimizes damage to remaining vegetation.
   b. All logs from felled trees are removed to their natural breaks so that no visible saw cuts remain. Sections that are left must be laid on the ground and not hung up on rocks or other trees.
   c. All stumps are flush cut. Stumps in campgrounds and high use areas are cut so that no portion is above ground level. Stumps along roadsides are cut so that no portion is more than three inches (7.6 cm) above the ground.
   d. All cut stump surfaces of living trees are treated with borax, which prevents innoculation by *Fomes annosus*.
   e. All limbs are lopped and either scattered or mechanically chipped. Chipped material is spread over denuded sites within areas.
3. Accurate maps and records will be maintained of all survey and removal work. In addition, investigation of causes and results of all tree failures will be documented."

taken from plans developed by Sequoia National Park

Vegetation

"A Planting Plan for the Visitor Center, Residences, and the Maintenance Area. . . .

A recent casual vegetative survey shows that the original plan is no longer an accurate representation of what is there. For instance, small groupings of red cedar have not been contained and have spread at a rapid rate. Other changes indicate that more informed management is necessary . . .

Action (New Maintenance, Research)

Through both research and judicious management, restore the vegetative patterns to those most compatible with nature and the use of the resource.

Research

Use old records to determine the extent of the vegetative changes at Pea Ridge and the severity of the encroachment of red cedar.

Work Program

Mechanical removal of some trees and bushes may be desirable. Re-establishment of certain species in certain areas could be done in order to conform with the natural patterns of the past more closely, and still be compatible with the use of the resource. . . ."

taken from plans developed by Pea Ridge Nat'l Military Park

Re-establishment of Tall-Grass Prairie

"There is evidence that there were portions of tall-grass prairie in the Pea Ridge vicinity during the time of the battle. As both a reconstruction of the past and preservation of a portion of the natural habitat, it is proposed to re-establish a portion of the original prairie . . ."

taken from plans developed by Pea Ridge Nat'l Military Park

Editor's Note: This particular natural resource management plan is motivated by the historic nature of the park, a factor which must figure into many park plans.

"Artificially revegetate sites subject to construction activities and developed areas where human impact impedes natural regenerative processes:

1. Conduct studies for the approximately 800 acres (324 ha) of developed recreation sites to establish the past vegetative mosaic for each site and project future conditions should present use patterns continue.
2. In accordance with the results of this research, conduct revegetation programs by transplanting native reproduction from nearby areas.
3. Prior to any construction activities, a plan for revegetation of the site will be made. The plan will be implemented after construction is completed, and before the next growing season. . . ."

taken from plans developed by Sequoia National Park

Construction Scar Repair

". . . The climate, vegetation, and soil characteristics of the recreation area, along with the underlying limestone formation, present a landform that is highly vulnerable to permanent scarring and erosion. Construction activities unless carefully controlled, contribute to this scarring.

Action (New Maintenance)

Specification for any construction shall require the removal of all rubble resulting from activities, replacement of the soil mantle that is lost, and reseeding of all construction sites with native vegetation that is consistent with the surrounding vegetation. . . ."

taken from plans developed by Amistad National Recreation Area

Cave Management

". . . Algae and Moss Growth Reduction Management"

Prior to 1971, algae and moss growth was checked in the vicinity of cave lights by spraying a bleach compound directly upon the growth. This procedure has been discontinued.

A research proposal has been suggested to develop an efficient, safe method for reducing algae and moss growth in the caves. The techniques developed in this study will be used in the reduction management program.

". . . The method of control developed to reduce algae and moss growth and maintain natural conditions in the caves will be used in the reduction management program. . . .

If the mosses and algae are permitted to grow unchecked, they will eventually become embedded in the rocks and formations and spread to previously unaffected areas . . .

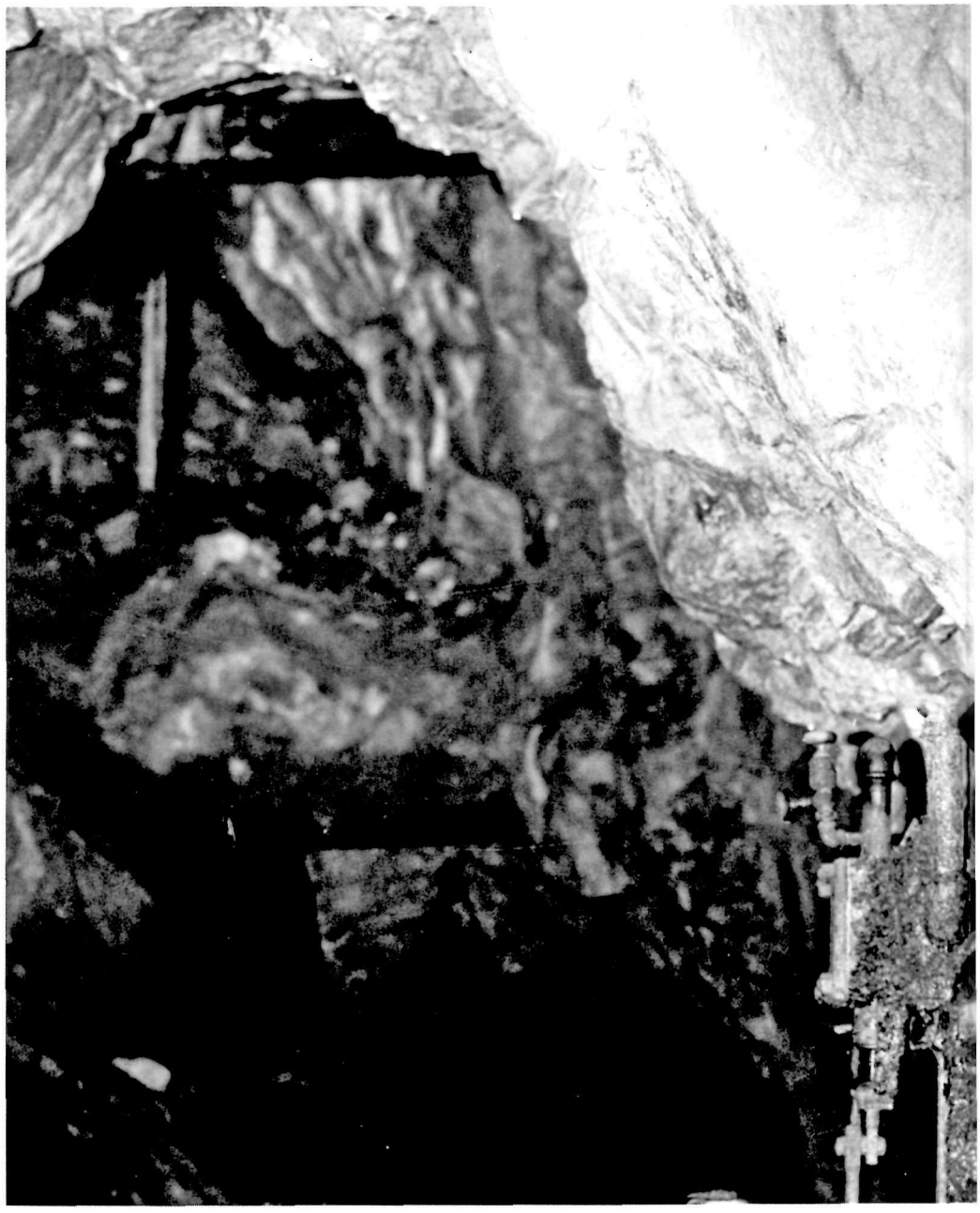
Alternatives:

a. Rewire the cave in areas of heavy algae and moss growth and periodically extinguish the lights for periods of two to three months.

b. Manipulate the lighting system by using different types of lights and wait to see if the desired change is taking place."

taken from plans developed at Lehman Caves National Monument

It is clear that resource management plans must take into account as much knowledge about the subject as is possible, the implications for all aspects of park management and the direct and long-term effects of every management stance. These excerpts serve only to highlight the importance of a well-considered long-term plan for natural resource perpetuation.

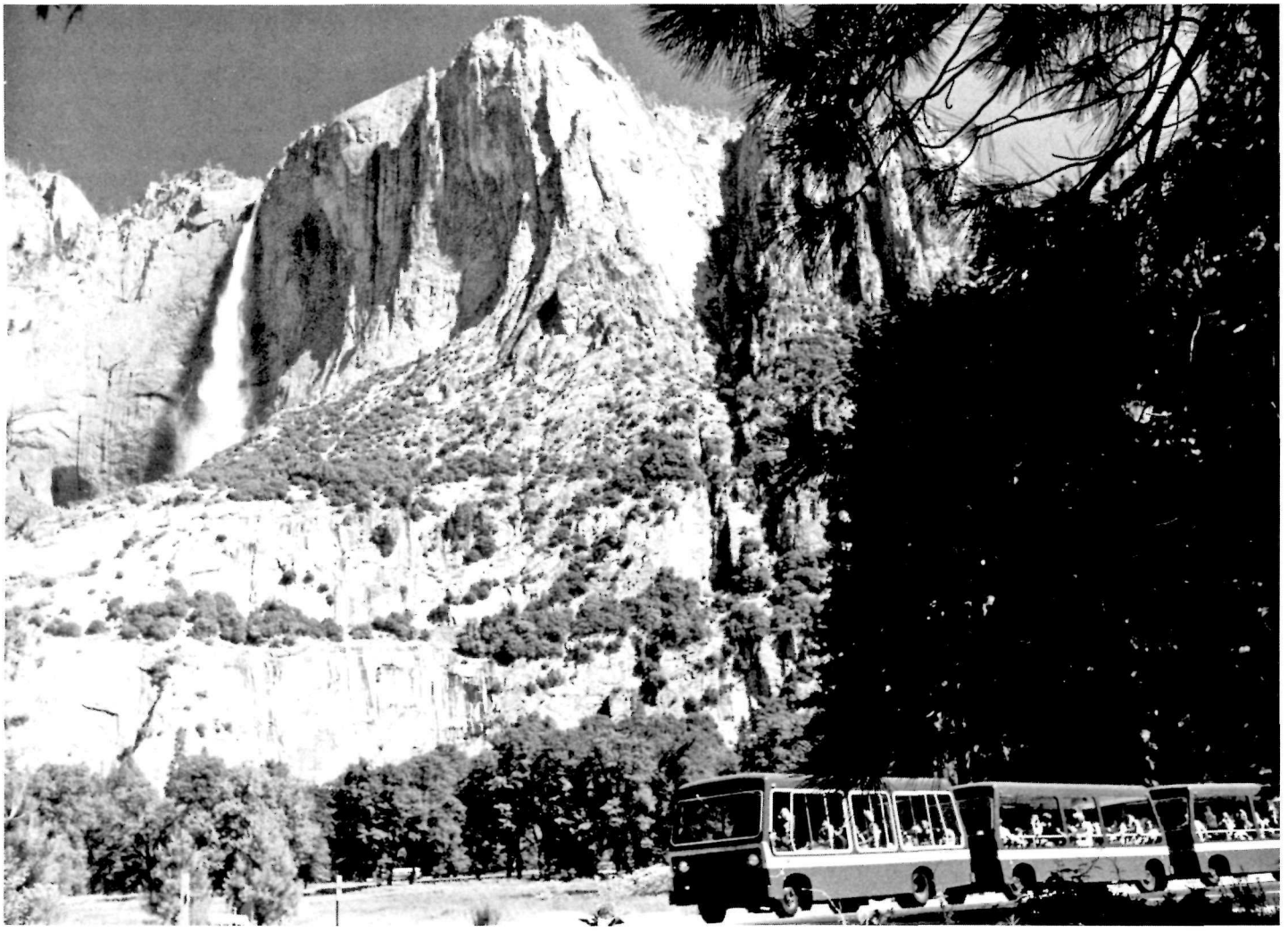


The process of natural resources planning is only a means to an end, that process should not overpower the achievements of the program. The end is the key measure of the success or failure of the planning. The perpetuation of the natural resources, in support of the objectives of the area, is the end or prime objective of the process.

Mr. Butts is a resource management specialist with the Natural Resources Management Division of the National Park Service.

Land Use Planning for Parks: What It's All About

by L. Lee Purkerson



Historically, Americans have viewed our land and its natural resources as a set of commodities waiting to be subdued, conquered and placed in servitude for human use, benefit, and profit. The industrial and economic strength of our nation, the comforts of our present national standard of living, and the capacity of this country to produce and consume, all attest to the unparalleled success of this great American conquest.

Another effect of this success has been the environmental ills that have resulted from our headlong pursuit of wealth, health, property and happiness. For example, it has been estimated that four billion tons (3.5 billion t) per year of erosion materials are scoured from used and misued lands, flushed into streams as silt and sediment, and end up suffocating fish and other aquatic life. Consider these facts:

- Urban sprawl consumes 730,000 acres (295,000 ha) per year of valuable agricultural lands and rural landscapes.
- Surface mining has virtually destroyed 1.7 million acres (687,990 ha) of prime wildlife habitat, polluting or otherwise degrading 280,000 acres (113,316 ha) of streams, rivers and lakes.
- More than 300,000 miles (482,790 km) of rights-of-way for overhead power lines have occupied four million acres (1.6 million ha) of land, while highway and airport expansions account for 300,000 acres (120,000 ha) of land per year.

And projections for the future are no less alarming.

The dimensions of land use planning are vast — from industrial uses, to open housing, to controlling growth. This article will focus on the impact of land use planning on natural resources and more particularly, on the federal government's role in natural resource management through land use planning.

Historical Perspective

Despite the increased awareness of the need to control the management of land to preserve our natural resources, the federal government's involvement in this area dates back to 1787. The seven original states surrendered 233.4 million

acres (94.4 million ha) of land for sale to private individuals or made donations for educational purposes, canals, railroads and colleges. This first move toward federal control of land was followed by years of abuses of natural resources, before Congress paved the way for the purpose of resource protection and conservation.

In 1872, the federal government established Yellowstone National Park, reserving lands from settlement, occupancy or sale in perpetuity. This event marks the first time in the world that a country set aside for preservation a great tract of untouched landscape "for the benefit and enjoyment of the people."

In 1875, public lands were set aside on Mackinac Island. In 1890, two million acres (809,400 ha) of land were set aside in Yosemite and Sequoia National Parks. In 1891, the Forest Reservation Act was passed, authorizing the President to set apart and reserve public lands bearing forests. And, in 1934, passage of the Taylor Grazing Act protected natural grazing lands.

In 1916, the National Park Service was created to manage the uses of parks so that their natural resources would be left unimpaired for the enjoyment and appreciation of present and future generations. Today, there are some 300 units within the National Park System encompassing more than 30 million acres (12 million ha). These include national parks, monuments, historic sites, military parks and battlefields, parkways, preserves, trails, rivers, recreation areas, seashores, lakes and lakeshores.

There has been a spate of legislation since the 1960's aimed at protecting natural resources. The laws which directly or indirectly contribute to the development of a federal land use policy include:

- The Wilderness Act of 1964
- The Wild and Scenic Rivers Act of 1968
- The National Trails System Act of 1968
- The National Environmental Policy Act of 1969
- The Coastal Zone Management Act of 1972

- The Federal Water Pollution Control Act of 1972
- The Marine Protection, Research and Sanctuaries Act of 1972
- The Endangered Species Act of 1973 (see story this issue)
- The Forest and Rangeland Renewable Resources Planning Act of 1974
- The Public Land Policy Act (the Organic Act) of 1976.

The Wilderness Example

Clearly, some of these acts involve conflicting land use management approaches, and overlapping administrative responsibilities. For example, the Wilderness Act established a National Wilderness Preservation System, composed of federally-owned lands, managed for public use and enjoyment in ways leaving them unimpaired for future use and enjoyment as wilderness areas. For the purposes of the Act, wilderness was defined as a landscape where the earth and its community of life remains untrammeled by man, where man is a visitor and does not remain.

Under the Act, wilderness areas are to be roadless, free of man's imprint, and should be at least 5,000 acres (2,000 ha) in size. The purpose of such areas is to provide solitude, primitive recreation and other scientific, educational, scenic, or historic values of interest to a broad spectrum of the visiting public. Land holdings of the National Park Service, the U.S. Forest Service and the U.S. Fish and Wildlife Service include wilderness areas. To date, there have been 127 separate areas designated as part of the Wilderness System, totalling about 13.1 million acres (5.3 million ha). The Bureau of Land Management has been charged, under the Organic Act of 1976, with a survey and study of the public lands under their jurisdiction for identification of potential wilderness areas which might also fit within this new system.

What are the implications of this one important overlap? Designation of a wilderness area within a national park, for example, imposes additional land use controls and resource protection mandates on a park manager, fortifying recreation and resource protection plans that might extend to the rest of the park. The use of motor vehicles in this area is forbidden, and some public uses may be

severely restricted. At the same time, areas which might well become a part of this wilderness system, are targeted by special interest groups from being so designated — mining companies, off-road vehicle enthusiasts, forestry or grazing interests, sport and commercial fishermen, hobbyists and *afficionados* of special recreation activities — all have reasons for preventing an area from being designated as wilderness.

Federal land managers, on the other side of the fence, may use this designation to protect fragile environments and valuable resources in danger of extinction. Ultimately, the side presenting the best case for an area to be or not to be declared as part of the wilderness system prevails.

Competing Land Use Designations

Another complexity is seen in the imposition of special land use designations on previously established areas. The National Trails System Act of 1968, for example, provides for the establishment of National Scenic Trails by the Congress, and the designation of Recreation Trails by the Secretary of the Department administering the lands. The Appalachian Trail, for example, passes through several areas administered by the National Park Service and the U.S. Forest Service. In managing these overlapping land use designations, the National Park Service has directed that the management of each shall be consistent with the other, hopefully precluding potential management conflicts.

The Wild and Scenic Rivers Act and the Marine Protection, Research and Sanctuaries Act (Marine Sanctuaries), both provide for establishing areas which may be superimposed upon existing federal reservations, public lands or forests. Marine sanctuaries, and estuarine sanctuaries, the latter established under the Coastal Zone Management Act, are principally for use by states in the designation and management of coastal areas possessing special significance or value.

The boundary of Glacier National Park, for example, runs down the center of the North Fork of the Flathead River, which may soon be set aside as a Wild River. Portions of Biscayne National

Monument were proposed as part of the Key Largo Coral Reef Marine Sanctuary, but were deleted before the establishment of the sanctuary due to a problem in determining management responsibilities. The Marine Sanctuary, as established, encompasses the adjacent John Pennekamp Coral Reef State Park.

State and Local Involvement

More than half of the 50 states have either adopted state land use planning programs or have implemented review authority and/or control over local planning agencies. Many states have made provisions for the planning and control of wetlands management and protection, power plant siting, flood plain management and surface mining, and have mechanisms for designating areas of critical environmental concern. A large number of states use tax incentives as a means of regulating land use.

The majority of coastal and Great Lakes states have provided for coastal zone management planning under the Coastal Zone Management Act. Two other important land and water use planning and control measures which may be employed by states are Sections 208 and 303 of the Federal Water Pollution Control Act.

Section 208 of the Act provides for areawide waste treatment management plans. This section encourages the regulatory aspects of water quality control and improvement rather than providing for further study. Section 303 deals with the establishment of water quality standards and water quality management planning on a complete water basin or watershed basis.

Sections 402 and 405 of the Act established the National Pollution Discharge Elimination System which requires permits for and places discharge limits on point sources of pollution. These sections also require clean-up schedules for non-complying sources of pollution. By maintaining high water quality standards and initiating programs to improve areas having degraded water quality in order to meet established water quality criteria and standards, states can attain a significant positive control over land use.

Solution to Conflicting Land Management Responsibilities

To get a better handle on land use planning and resource management, the National Park Service has adopted a land classification system which divides areas under its jurisdiction into land zones and subzones. The same system might well apply to local land uses in parks. The major categories are:

- Natural Zones
- Historic Zones
- Development Zones
- Special Use Zones.

These classifications are refined into subzones including: wilderness, environmental protection, outstanding natural features, and natural environment subzones that make up the Natural Zone.

Overall, the Park Service has tried to develop plans which are dynamic and flexible, to allow for necessary modifications in time aimed towards effective resource management. The classifications are used not only to make distinctions in areas, but to describe in general terms the kinds or quality of resources present. Such classifications prescribe in detail the land use philosophy and the degree or kind of resource management to be applied in each instance. Even with a system of classification, there is need for updating to make it adaptable to park planning procedures and resource management programs.

Making Zoning Within a Park Work

Visitor use zoning for certain park recreational activities could become an important park management technique. Recreational use zoning is especially applicable in shallow coastal and sea grass flats, inland wetlands, and some selected plant and animal communities which are highly susceptible to damage from recreational uses and activities.

Boat prop ruts across shallow sea-grass flats can be particularly damaging as can boat collisions with coral reefs. Viewing of coral reefs by skin or SCUBA divers, for example, is incompatible with either boating over the reefs or fishing (either hook and line or spear fishing). Both boating and fishing pose a direct hazard to swimmers. An added danger is posed to divers viewing a reef that may be used by fishermen — the fishing tends to attract sharks!

Boating should be excluded from shallow coral reef areas to avoid boat-coral collisions, which may be equally damaging to both boats and reefs. Anchoring of boats on or near coral reefs has literally played havoc when anchor chains have worked across the brittle reef community. Dragging anchors and the breaking loose of anchors have decimated some reefs.

Education on proper boat operations, coupled with marking of waterways, motor and boat size limitations, speed limits or no-muddy-wake rules, and strict enforcement, can alleviate major motor boating problems.

Marked anchorages and/or anchor buoys, and markers, can help keep boaters off reefs and other sensitive areas.

Power boating can be excluded from shallow marine gardens where canoeing, rafting, or swimming might be appropriate. Wading in some areas must be precluded since coral and algal beds colonizing deep in accumulations of soft sediment can be decimated by a visiting party of waders. Viewing of outstanding natural features, whether in the water world, the forest or the desert, coastal sand dune or an arctic tundra can most often be accommodated by provision of cleverly improvised natural trails, viewing platforms, chambers or other means. Such innovations provide the human visitor with an intimate glimpse of happenings without distracting or harming the natural phenomena or creatures being studied.

The enjoyment and educational opportunities of natural areas, along with the long-term benefits gained by park visitors, can be attained by careful land-use planning and management and designation of areas of natural environment as preserves for present and future generations to appreciate.

Issues in Managing Shoreline and Underwater Park Resources

by L. Lee Purkerson

Underwater and shoreline parks have been established in environments ranging from tropical to sub-arctic, in areas that range in character from wilderness to megalopolis. These parks exist to protect natural resources, to preserve historic structures, to provide outdoor recreation areas, or, more often than not, a combination of these purposes.

Problems in resource and management protection at shoreline and underwater parks stem largely from human activities or developments outside park boundaries and from the need to fulfill visitor needs in the use and enjoyment of park resources which must be balanced against one another.

Clearly, a basic park management objective is to provide for visitor use and enjoyment. But at the same time, park resources must be protected and preserved for future generations.

Aquatic-related parks, under the administration of the National Park Service, for example, range in size from less than a hectare to 882,700 hectares (353,080 acres). Uniform park administration of these areas is often complicated by a variety of jurisdictions imposed on these areas. Sometimes, the federal government has exclusive jurisdiction, while in other instances, this responsibility is shared with state officials. In still other instances, the state has the larger share of responsibility, but the federal government maintains an interest.

What are some of the human activities which disrupt the balance in natural resources in these parks? Solid and liquid waste disposal, oil and chemical spills, diversion of freshwater flows above a park area, dredge and fill, weapons testing and gas and mineral extraction, likewise play a part in threatening the preservation of natural aquatic resources. In addition, visitor needs — swimming areas, fishing and boating, all play a potentially threatening role in this balance.

Let's look at some of the visitor use activities and their impact on a park:

- At Cape Cod National Seashore, a beach began to be frequented by nude bathers, an act which might have other repercussions, but certainly could not affect the natural resources of the area . . . or so one would think. Word traveled rapidly, however, drawing not only just nude bathers, but a host of voyeurs overflowing the cross-dune trails leading to the beach. Off-road vehicles used by

those who wanted to get there faster did more harm by extensively damaging the dune vegetation necessary to stabilize the beach.

- At Fort Jefferson National Monument, coral reefs have been destroyed by boats anchoring near and crashing into them.
- Large power boats traversing the shallow channels in Biscayne National Monument leave the ordinarily crystal clear bay waters perpetually turbid. In addition, most of the recorded manatee deaths in Florida are related to boat-caused injuries.
- The submerged "seagrass" flats common to South Florida's underwater parks are a great threat to boat motors and, when a boat does run afoul of this grass, it can cause permanent scars in the form of "prop ruts," when coupled with tide-induced erosion on the floor of the underwater park.
- The potential damage to nesting birds by visitors to a shoreline area has been admirably covered in an article by Dr. Paul A. Buckley and Francine G. Buckley in the July/August/September '76 issue of *Trends* magazine. Suffice it to say that such intrusion can do lasting damage to whole communities of birds.
- Fishing can deplete the stock of exploited resources or frighten them to the extent that they may refuse to frequent certain populated areas near the coast. Commercial fishing, in particular (see story this issue by Gary Davis) may do a great deal of damage to species not on the fisherman's list of desirables, but who are caught just the same. For example, at Everglades National Park, crocodiles often become caught in mullet nets and may be drowned or killed by fishermen. Shrimp trawlers knock over corals, dislodge sponges, and catch thousands, if not millions of pounds of marine life that is cast over the side either dead or near death.
- Wave action working on a lobster or crab trap dropped on a coral reef may slowly grind a path of complete destruction through that reef. Fishing over or near reefs is often sport for the fisherman. However, it also tends to attract sharks who may linger when skin and SCUBA divers come to watch other fish hover in the reef.

Solutions to these problems have, in fact, become almost routine. Uniquely designed developments which facilitate visitor use with a minimal impact on the natural environment often suffice. Elevated boardwalk nature trails may serve as a typical example. In some instances, fenced trails with treated surfaces to keep ecological damage to a minimum may help park visitors across fragile environments. At the same time, they may serve to protect the visitor from venturing into areas that are less than safe.

To avoid visitor-use conflicts, zoning of areas may be required (see story on land-use planning to protect natural resources, this issue). Active educational programs and enforcement can be effective. Well-designed and memorable education efforts are particularly crucial to fragile areas when visitor use conflicts with the functions of wildlife, for example, bird rookeries, turtle nesting sites, critical endangered species habitats (see story this issue), or fragile and unique plant communities, or where the visitor might be endangered.

Whereas man may have to be constrained in his use of natural areas, the influences of natural forces should be left unrestrained as much as possible. The best response to beach erosion and other impacts naturally arising is to work in concert with nature whenever possible. Compatible land use planning would go a long way toward setting the stage for nature to play its own part. Certain legislative efforts have been made at the federal and state levels, which clearly seek to protect our natural resources. There is a special challenge in managing shoreline and underwater parks, it requires a gentle but firm hand with regard to man's use of the area, and a careful eye on nature's flow.

Mr. Purkerson is an environmental specialist/manager with the Natural Resources Management Division of the National Park Service.

The Special Challenge of Endangered Species and Natural Resource Management

by John G. Dennis

As a manager of a park or recreation area, you are always working to maximize facilities to meet visitor needs while still trying to preserve the natural resources of your area. Your planning may have identified a creek bottom where a small dam might make an ideal swimming hole. You may have discovered a delightful clifftop overlook and a workable approach route for a graded trail. You have a visitor center and a parking lot near the swimming pond and all your budgets have been approved and the actual plans are in the final stages of completion. Everything is moving along nicely, the environmental analysis of your plans is out for public review and everything seems to be in good working order.

But have you considered that rare fish in the creek, the strange plant on the trail's edge, the unusual squirrel nesting in the trees near the trail?

Whether you are working in a park filled with crocodiles or squirrels, it is important that you consider the impact of your actions on the endangered species in your park (see box for list of U.S. endangered species).

These tiny and not so tiny creatures are protected by a 1973 Endangered Species Act designed "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions . . ." already identified by this Act.

The law defines "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the *Class Insecta* determined by the Secretary (of the Department of Interior) to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man."

A "threatened species" is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act also provides for recognition of habitat critical for the continued existence of a population of an endangered or threatened species. It provides for the preservation of that habitat either through acquisition by an appropriate federal or state agency or through prohibiting any actions authorized, funded, or carried out by any federal department or agency that would cause destruction or modification of that habitat.

In addition, with certain exceptions, the Act proscribes the taking of any endangered fish or wildlife species by any person subject to the jurisdiction of the United States. It prohibits the importing, exporting, or handling in interstate commerce of any endangered fish, wildlife, or plant species. It also lists penalties for violation of any regulation issued by the Secretary of the Interior to protect an endangered or threatened species of fish, wildlife or plant. The list of species deemed endangered or threatened is constantly being revised.

The Act offers a mechanism by which citizen suits can be brought to stop the actions of any person or governmental agency or instrumentality who is alleged to be in violation of the Act.

An important provision of the Act is its strong support of federal and state cooperation, especially with respect to resident fish and wildlife.

Who Is Responsible?

The administration of provisions of this Act dealing with terrestrial, freshwater, and some marine species and the listing of all species is assigned to the Secretary of the Interior and administered by the U S. Fish and Wildlife Service. Those provisions of the Act that deal with selected marine species are assigned to the Secretary of Commerce and administered by the National Marine Fisheries Service. Aspects of the Act dealing with importation and exportation of terrestrial plants are assigned to the Secretary of Agriculture. The Secretaries of State and Treasury are involved with some of the provisions of the Act regarding international agreements and trade, respectively. Unlike many other pieces of legislation, the provisions of the Endangered Species Act are administered in varying degrees by a host of federal and state agencies, and are capable of influencing the everyday actions of each of us as private citizens, and to a greater degree if we act as public servants.

Making a Survey

Having absorbed this background about Public Law 93-205, how do you now proceed with the development of your management area without risking violation of the Endangered Species Act? The first step you should make is to examine the published lists of endangered and threatened species (see below) to determine what kinds of endangered or threatened plants and animals do occur, or might possibly occur, anywhere in or near your management area or in the biological communities characteristic of your area. There are some 181 species in the U.S. on the list (see box).

The second step is to identify the species accurately and, if necessary, the subspecies, of as many plants, fish and wildlife present in or near your area as you can. Keep in mind that the terms plant, fish and wildlife used in the Act collectively include all organisms present in your area, whether oak tree, fox, trout, hair moss, earth worm, toadstool fungus, or nitrifying bacterium.

In conducting this inventory, obtain enough information to show whether the population of each species is abundant, common, infrequent, or rare; and whether the population resides within the boundaries of your area throughout the year or whether it occupies areas outside your boundary from time to time. Plan to devote extra effort to any entity you find that is classified as endangered or threatened, or that is a closely related subspecies or species of a listed entity. Devote extra effort to any entity that is uncommon in your area. Finally, use scientific literature and your own observations to identify all habitat elements used by the listed endangered and threatened species in your area, as well as places used by any uncommon species you may have.

The Case of the Crocodile

For example, suppose you are managing an area that has a number of American crocodiles resident in it. The first item you will discover as you compile information about the area is that the American crocodile is listed as an endangered species throughout its entire range in the U.S., Central America and Coastal South America. The second piece of information you will obtain, is that for the U.S., critical habitat for the American crocodile formally has been designated in the area that includes:

All land and water within the following boundary in Florida: beginning at the easternmost tip of Turkey Point, Dade County, on the coast of Biscayne Bay; thence southeastward along a straight line to Christmas Point at the southernmost tip of Elliott Key; thence southwestward along a line following the shores of the Atlantic Ocean side of Old Rhodes Key, Palo Alto Key, Angle Fish Key, Key Largo, Plantation Key, Windley Key, Upper Matecumbe Key, Lower Matecumbe Key, and Long Key, to the westernmost tip of Middle Cape; thence northward along the shore of the Gulf of Mexico to the north side of the mouth of Little Sable Creek; thence eastward along a straight line to the point of beginning."

Endangered Species Common names

Mammals

Bat, gray
Bat, Hawaiian hoary
Bat, Indiana
Bear, brown
Cougar, eastern
Deer, Columbian white-tailed
Deer, key
Dugong
Ferret, black-footed
Fox, San Joaquin kit
Manatee, West Indian (Florida)
Mouse, Salt Marsh Harvest
Panther, Florida
Prairie Dog, Utah
Pronghorn, Sonoran
Rat, Morro Bay kangaroo
Wolf, eastern timber
Wolf, gray
Wolf, Mexican
Wolf, Northern Rocky Mountain
Wolf, red

Birds

Akepa, Hawaii (honeycreeper)
Akepa, Maui (honeycreeper akepuie)
Akialoa, Kauai (honeycreeper)
Akiapolaau (honeycreeper)
Albatross, short-tailed
Bobwhite, masked (quail)
Condor, California
Coot, Hawaiian
Crane, Mississippi sandhill
Crane, whooping
Creeper, Hawaii (honeycreeper)
Creeper, Molokai (Kakawahie, honeycreeper)
Creeper, Oahu (Alauwahio, honeycreeper)
Crow, Hawaiian (Alaia)
Curlew, Eskimo
Dove, Palau ground
Duck, Hawaiian (Koloa)
Duck, Laysan
Duck, Mexican
Eagle, Southern bald
Falcon, American peregrine
Falcon, arctic peregrine
Finches, Laysan and Nihoa (honeycreepers)
Flycatcher, Palau fantail
Gallinule Hawaiian
Goose, Aleutian Canada
Goose, Hawaiian (Nene)
Hawk, Hawaiian (Io)
Honeycreeper, crested (Akohekohe)
Kite, Florida Everglade (snail kite)
Megapode, La Perouse's
Millerbird, Nihoa (warbler)
Monarch, Tinian tyrant flycatcher
Nukupuus, Kauai & Maui (honeycreeper)
Oo, Kauai (Oo Aa (honeyeater)
Ou (honeycreeper)
Owl, Palau
Palila (honeycreeper)
Parrot, Puerto Rican
Parrot, thick-billed
Parrotbill, Maui (honeycreeper)
Pelican, brown
Petrel, Hawaiian dark rumped
Pigeon, Puerto Rican plain
Prairie chicken Attwater's greater
Poo-uli
Rail, California clapper
Rail, light-footed clapper
Rail, Yuma clapper
Shearwater Newell's Manx
Sparrow, Cape Sable
Sparrow, dusky seaside
Sparrow, Santa Barbara song
Starling, Ponape mountain
Stilt, Hawaiian
Tern, California least
Thrush, large Kauai
Thrush, Molokai (Olomau)
Thrush, small Kauai (Puaiohi)
Warbler (wood) —Bachman's
Warbler (wood) Kirtland's
Whip-poor-will Puerto Rican
White-eye, Ponape great
Woodpecker, ivory-billed
Woodpecker, red-cockaded

Reptiles

Alligator, American
Alligator, American
Boa, Puerto Rico
Crocodile, American
Lizard, blunt-nosed leopard

and that within this area, any "existing manmade structures or settlements which are not necessary to the normal needs or survival of the species" are excluded from designation as critical habitats. By plotting this information on the wall map, you discover that your area falls within the designated critical habitat. Your search of the scientific literature shows you what aspects of the crocodile's life history are important—such as where and when it nests, how long its eggs must incubate; what natural and man-made occurrences are likely to cause death of eggs, prevent laying of eggs, or prevent females from breeding; or what kinds of foods young, immature, and mature crocodiles eat. Your field survey of your area generates such information as how many crocodiles of each sex, each class, and breeding condition are present; where and how many natural and potential nesting sites your area contains; which portions of your area are exceptionally important crocodile feeding stations and why; where and why crocodiles

Snake, San Francisco garter
Salamander, desert slender
Salamander, Santa Cruz long-toed
Salamander, Texas blind
Toad, Houston

Fishes

Bonytail, Pahranagat
Chub, humpback
Chub, Mohave
Cisco, lonjaw
Cui-ui
Dace, Kendall Warm Springs
Dace, Moapa
Darter, bayou
Darter, fountain
Darter, Maryland
Darter, Okaloosa
Darter, snail
Darter, watercress
Gambusia, Big Bend
Gambusia, Clear Creek
Gambusia, Pecos
Killifish, Pahrump
Madtom, Scioto
Pike, blue
Pupfish, Comanche Springs
Pupfish, Devil's Hole
Pupfish, Owens River
Pupfish, Tecopa
Pupfish, Warm Springs
Squawfish, Colorado River
Stickleback, unarmored three-spine
Sturgeon, shortnose
Topminnow, Gila
Trout, Arizona
Trout, Gila
Trout, greenback cutthroat
Trout, Lahontan cutthroat
Trout, Paiute cutthroat
Woundfin

Insects

Butterfly, Bahama swallowtail
Butterfly, El Segundo blue
Butterfly, Lange's metalmark
Butterfly, Lotis blue
Butterfly, mission blue
Butterfly, San Bruno elfin
Butterfly, Schaus swallowtail
Butterfly, Smith's blue

Clams

Mussel, Alabama lamp pearly
Mussel, Appalachian monkeyface pearly
Mussel, birdwing pearly
Mussel, Cumberland bean pearly
Mussel, Cumberland monkeyface pearly
Mussel, Curtis' pearly
Mussel, Dromedary pearly
Mussel, fat pocketbook pearly
Mussel, fine-rayed pigtoe pearly
Mussel, green-blossom pearly
Mussel, Higgin's eye pearly
Mussel, pale lilliput pearly
Mussel, pink mucket pearly
Mussel, rough pigtoe pearly
Mussel, Sampson's pearly
Mussel, shiny pigtoe pearly
Mussel, Tampico pearly
Mussel, tuberculed-blossom pearly
Mussel, turgid-blossom pearly
Mussel, white cat's
Mussel, white warty-back pearly
Mussel, yellow-blossom pearly
Pimpleback, orange footed

move during the course of the day and during the course of the year; and whether there are any influences from outside your boundaries that might affect the chances of survival for your crocodiles. By having information of this kind readily at hand, you will be able quickly to assess the probable impact on crocodiles of any manipulation or development that might be instituted in or near your area, such as a stream diversion or damming of a stream.

So far, threatened and endangerd species of animals recognized by the U.S. represent only mammals (281 taxa worldwide, 37 U.S.), birds (211 taxa worldwide, 67 U.S.), reptiles (55 taxa worldwide, 9 U.S.), amphibians (13 taxa worldwide, 4 U.S.), fishes (44 taxa worldwide, 34 U.S.), snails (1 taxon worldwide, none U.S.), clams (24 taxa worldwide, 22 U.S.), and butterflies (8 taxa worldwide, all are U.S.). See box indicating the common names of the most current list of U.S. endangered and threatened species.

Although the Act includes provisions for protection of endangered and threatened plants, only a few plants have been designated, and these were added very recently. However, approximately 1,850 taxa of vascular plants have been proposed for listing (see proposed listing published on Wednesday, June 16, 1976, *Federal Register*, Vol 41, No. 117, pp. 24524-24572). It is likely that most of these taxa will receive formal designation either as endangered or threatened species.

With this information in hand, you may wind up discovering that the rare fish is listed as threatened and that the creek in your park has been designated as a critical habitat, the strange plant is part of an isolated population of a species that elsewhere is abundant and hence is not designated as threatened or endangered, the falcon is listed as endangered and the salamander has been proposed for listing as endangered, but no critical habitat has been determined for either, and the squirrel is endangered and the area it occupies has been recognized as critical habitat.

What to do? The first step is to ensure that no one knowingly harms any of the listed species. The second step is to consult with the regional rare and endangered species office of the U.S. Fish and Wildlife Service (or National Marine Fisheries Service, if appropriate). Such Fish and Wildlife Service offices may be reached through the addresses listed in the box below:

Region 1: P.O. Box 3737, Portland, Oregon 97208; Region 2: P.O. Box 1306, Albuquerque, New Mexico 87103; Region 3: Federal Building Fort Snelling, Twin Cities, Minnesota 55111; Region 4: 17 Executive Park Drive, NE, Atlanta, Georgia 30323; Region 5: McCormack P.O. and Courthouse, Boston, Massachusetts 01209; Region 6: P.O. Box 25486, Denver Federal Center, Denver, Colorado 80225; Alaska: 813 D Street, Anchorage, Alaska 99501; and Washington, D.C.: Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240.

Getting Help

If your listed species is resident in your state and if your state is one of 17 states (Arkansas, California, Colorado, Delaware, Florida, Maine, Maryland, Michigan, Missouri, New Jersey, New Mexico, New York, North Carolina, South Carolina, Virginia, Washington, and Wisconsin) that already has a cooperative agreement with the Fish and Wildlife Service or is one of 8 states (Alaska, Georgia, Hawaii, Nebraska, Puerto Rico, South Dakota, Tennessee, and Utah) that soon may have such an agreement in effect, you probably will be referred to the state endangered species office. Whatever office you ultimately consult will review your ecological data and proposed actions and will suggest whether your situation falls within the requirements now being promulgated for initiation of a formal consultation procedure. Under federal law, such a formal consultation procedure will be required for any federal agency that maintains involvement in, or control of, an action that could jeopardize the continued existence of a threatened or endangered species or adversely affect a recognized critical habitat. Whether such a formal consultation would be required under state law would depend on whatever state laws and regulations had been adopted in accordance with a cooperative agreement.

In general, a formal consultation would include your written request for consultation, a "threshold examination" by the appropriate endangered species office, a determination that further consultation will or will not be required based on whether the proposed action will adversely affect the species or its habitat, a review of information you supply that is adequate for making a biological opinion if it has been decided that further consultation is required, and the rendering to you of that biological opinion. There are two aspects of this consultation procedure that ensure that the ultimate responsibility remains in your hands. First, you must ensure the availability of adequate information for making the biological opinion. Second, it remains up to you, when making your decision regarding the proposed action, to determine how to use the formal biological opinion and any accompanying suggestions given you.

What Next?

After making appropriate consultations you find that, although the entire creek is listed as a critical habitat, the threatened fish can tolerate various depths and temperatures of water and some degree of reduction of water quality for its juvenile and adult life stages, but its spawning occurs only in shallow, gravel bottomed tributaries that would become one foot too deep if the dam were built as planned. You determine that you can avoid adversely modifying the critical habitat by making a smaller impoundment that would maintain a lower water level than originally planned, but that still would be more than adequate for your recreational needs, so you go ahead with a modified project.

Handling Borderline Cases

The rare plant occupies some habitat that is outside the reduced flood area of the modified dam. You conclude that since the species is not listed, and since you will be maintaining a population of it in your area, you need not preclude constructing the swimming area. You also accept the

possibility that your population of the plant in the future may become recognized as an endangered or threatened population of a more generally unlisted species, as is the situation with the grizzly bear in the conterminous 48 states, and that as a result of such a *post facto* listing, your federally-funded dam construction project may have to be halted at least temporarily even though by that time it might nearly be complete. Such an action could be ordered by the courts in accordance with a precedent set by a suit that at least temporarily has stopped completion of the $100 million Tellico Dam on the Little Tennessee River because closing the dam would destroy some critical habitat of a small, endangered fish, the snail darter, that was not known even to occur in the stretch of river scheduled for flooding until six years after construction of the dam had begun. A similar precedent has been set with the endangered Mississippi sandhill crane, in which construction of an interchange and opening of borrow pits for an interstate highway has been stopped by court action to prevent commercial development that would reduce significantly the chance of survival of the last 40 individuals of this non-migratory subspecies.

It turns out that your falcon nest only recently began to be used, and that the nest site had not been declared critical habitat because it was too far from the main area of distribution of the species. Even though it is not formally listed as critical habitat, you decide to treat it as critical and abandon the plan to develop a scenic overlook from the cliff. Instead, you arrange to relocate the trail so its destination becomes the top of the hill a half mile away, and you clear enough trees to develop a scenic overlook equally as good as what was available at the cliff. In relocating the trail you are able to avoid the stand of oak trees that constituted the designated critical habitat for the squirrel, so you do not have to devote further concern to that conflict.

The case of the salamander creates your greatest problem. You have learned that the salamander is unique to your cave and the other caves that are part of the same system, and that the entire cave system probably will be designated as critical habitat. You also have discovered that construction of any kind of facility in the area you had selected would create sufficient disturbance to natural water runoff and drainage patterns to threaten the survival of your cave's salamanders. Your immediate reaction, since you had planned all along to have the facility operated by a concessioner, is to have the concessioner privately build his own facility nearby, but outside, your area and hence outside the jurisdiction of the restriction imposed on you by the Act because of the federal funds and permits that you have had to obtain. The concessioner, of course, will have to meet state law regarding the endangered salamander, but you assume that should be no problem since none of his actions directly would destroy any salamanders. However, then you remember the litigation concerning the Devil's Hole pupfish, in which the federal government successfully obtained a court order to limit the amount of groundwater that a private individual could withdraw from his own land for irrigation and other purposes to only that amount which could be removed without causing a drawdown of the water level in a spring-fed, 10 by 40 foot (3.05m x 12.2m) pool on nearby federal land that contains the only known population of an endangered species of pupfish. The precedent set by this case suggests that you should work closely with the concessioner to ensure that none of his construction or operational activities would produce side effects that would affect adversely either the salamander or its habitat.

The foregoing examples tell you several things. First, the implications of the Endangered Species Act of 1973 become more pervasive the more involved you get. Second, it is possible to take many, most, or even all of the actions you wish to take without violating the law if you have thought out your course of action carefully, with foresight, and with coordination. Third, this combination of care, foresight, and coordination requires your having in hand a good base of factual knowledge about the resources entrusted to your care.

Mr. Dennis is a natural resources management specialist with the National Park Service.

Urban Wastes for Soil Rejuvenation

by James C. Patterson

One of the constant battles all park administrators must face is that while trying to practice conservation of a natural resource, parks are continually becoming the focal point for record visitation; thus, the natural resource often receives the heaviest impact. Clearly, if some restraints are not imposed, constant use will lead to a degradation of the very resource the park celebrates by its existence.

The Solid Waste Generation Problem

The solid waste generated by man is the major challenge facing all parks, and urban parks in particular. In 1950, the average American generated about 2.2 pounds (1 kg) of refuse per day. In 1970, that amount had risen to 4.0 pounds (under 2 kg) per day and it's expected that by the late 1970's, we may be producing as much as 8 to 10 pounds (3.5 to 4.5 kg) a day.

At the same time, the average individual requires about 100 gallons (378.5 l) of water a day to maintain his household and personal needs. The same person generates about .2 pounds (less than .1 kg) of settled solids per day from primary and secondary treatment.

It becomes apparent that there is a need to take a critical look at recycling "wastes" and developing a "waste-to-resource" system. Composting technology offers one very attractive mechanism toward this goal.

Constitution Gardens: A Practical Application of Urban Wastes

The story of Constitution Gardens is the story of a frog turned into a prince. Once a highly impacted area spanning 42 acres (17 ha) in Washington, D.C. near the Lincoln Memorial, this plot had been devoted to "temporary" buildings erected during World War I to house military personnel offices. These structures occupied the site until 1970 when they were finally demolished.

At that point, some subsoil fill (taken from depths of 40-60 feet (12-18 m) was spread over the area to a depth of about 2-10 feet (.6-3 m) above the street elevation. The material was about as dense as concrete, and for several years, it was the parking lot for the annual Folklife Festival on the Mall, jointly sponsored by the Smithsonian Institution and the National Park Service.

The development of the Gardens began in 1974 as a bicentennial project. The major question confronting the planners was how to most economically modify the existing dense soil. The following alternatives were proposed:

1. Utilize the existing dense soil;
2. Restructure the soil using urban "waste," or;
3. Replace the existing soil with about 18 inches (45.7 cm) of topsoil.

Economics prevailed, and the decision was made to restructure the soil using urban "waste." In fact, as far as anyone in the Park Service is aware, it is the single, largest soil rejuvenation project ever undertaken in the country. However, to better understand the effort, it might be well to discuss in general, some of the important aspects of urban soils.

Soil formation is governed by parent material, climate, micro-organisms and topography, each acting in concert with the other over time. These diverse factors, naturally enough, produce diverse soils capable of supporting a kaleidoscope of vegetation.

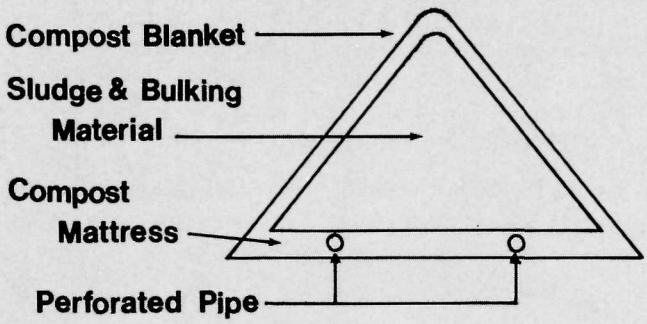
The principal characteristic that differentiates natural soils from their urban counterpart is their extreme compaction. Naturally occurring soils are much less compacted, having greater porosity, enabling them to maintain a desirable balance between the soil moisture status and the soil atmosphere. Conversely, urban soils, due to their compaction, have a much less desirable relationship between soil atmosphere and the soil moisture regime. Generally, these soils contain very low percentages of pore space, and tend to have low percentages of oxygen and low percentages of available moisture for plant use. These differences are responsible for my work in recycling urban produced organic wastes.

Beyond congestion and impact on the soil, heavy visitor use of an area generates large volumes of organic wastes in the form of organic refuse and sewage. In the National Capital Region of the National Park Service, a compost developed by the U.S. Department of Agriculture (USDA) at Beltsville, Md., has been used to aid in soil rehabilitation.

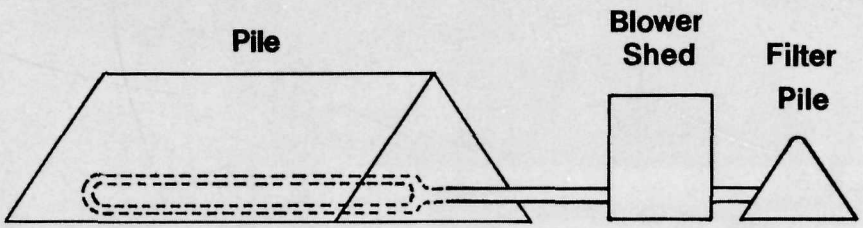
In rejuvenating the soil at Constitution Gardens, a decision was made to use the USDA compost (developed from an aerobically digested mixture of sewage sludge and wood chips) along with leaf mold which had been aged and stockpiled (see box). All these ingredients were blended and mixed to create an 18-inch (45.7 cm) mantle of soil for the landscaping of the park. Despite the fact that every effort was taken to rejuvenate the soil, a large number of trees surrounding walkways did not survive. After careful study, it was determined that there was an excess of moisture in these areas and the trees were dying of "wet feet," or root rot. The topsoil used for the walkway areas had become so dense that there was a high run-off, and the turf was not sufficiently permeable to absorb large

TYPICAL COMPOST PILE

CROSS SECTION



LONGITUDINAL SECTION



The compost pile pictured above is easily adaptable to a full range of climatic conditions. First, one lays down a mattress of organic material about 12 inches (30.5 cm) thick. Into this mattress, place an oval of 4-inch (10.2 cm) PVC perforated drain pipe. The ends should be joined in a "T". Absorbent organics, (i.e., sawdust, paper, wood chips) are thoroughly mixed on an adjacent mixing pad. The raw sewage is dumped onto these two types of organic materials. In about 20 minutes, the liquid from the sewage is absorbed and a front-end loader transfers the mixture onto the mattress, forming the compost pile. At this point, an insulating blanket of wood chips, compost or other organic, is placed over the mixture of sewage and organic materials. By increasing or decreasing the thickness of the insulating blanket, one can adapt this system to almost any climatic condition.

At the "T" joint, one end of a solid piece of PVC pipe is joined with the remaining end and connected to the intake end of a 1/3 horsepower blower-time clock apparatus. At the exhaust end of the blower, a second section of PVC is run into a filtration pile of organics. The blower system is turned on for about 2-4 minutes per 20 minute period for about a week to 10 days. From this point, the timing is regulated by the percent of the oxygen content and the centigrade temperature of the pile. Complete composting takes just about 4 to 5 weeks with this system. Once complete, the pile is dismantled and stockpiled for future use as organic bulking agents to be used in the field.

amounts of moisture. Although the planners of the park had anticipated some problem, they were not prepared for the dimensions of tree mortality experienced.

Despite this setback, which is now being corrected by the installation of drainage systems around the walkways, the overall effect of the park is impressive. The park is lined with trees, contains a small man-made lake, and has been completely transformed from an eyesore to an eyeful of beautiful vegetation, made possible only by the inclusion of the enriched soil mixture.

Another Effort in Soil Enrichment

For the past few years, the area adjacent to the reflecting pond has been the site of the Smithsonian's Folklife Festival, drawing millions of Americans. To protect the soil and enrich it after the impact of several weeks and months of heavy visitor use, the Park Service decided to cover the area with a layer of one to three inches (2.5-7.6 cm) of wood chips. This material was then mixed with the compost developed at the USDA site and the existing soil to form a new soil mantle after the Festival. In addition, a moderate application of fertilizer was applied and mixed in with other ingredients, and the soil was seeded.

This same combination of ingredients (see box for details on compost mixture) has been responsible for the rejuvenation of soils in many urban parks throughout the metropolitan Washington, D.C. area.

C & O Canal—The People Enrich the Park

Approximately 27,000 gallons (102,195 l) of sewage is produced each year by visitors at the C & O Canal, an historic national park which runs parallel to the Potomac River in Washington and neighboring Maryland. The sewage treatment plants of local municipalities were already overloaded, so the park took it upon itself to recycle the sewage for stockpiling for soil enrichment.

Essentially, the process involves taking untreated sewage, which is about 95 per-

cent liquid, adding sawdust, wood chips and compost to make a more solid product. Using composting procedures, the sewage becomes essentially free of pathogenic organisms (composting temperatures approach 176°F (80°C)) and yields a low analysis organic fertilizer and soil amendments.

The cost of the whole operation for the first year was about $4,400, just over twice the cost of disposal into municipal systems. Much of that cost was due to careful planning and landscaping of the site to avoid any possible contamination. The cost-benefit ratio will however, diminish in time, and a stockpile of organic bulking agents is being built up.

Experimental Compost Mixtures

Pile 1
50% leaves
25% wood chips
25% sludge

Pile 2
50% leaves
50% horse manure

Pile 3
33% leaves
50% horse manure
17% wood chips

Pile 4
45% leaves
34% horse manure
21% paper

Mr. Patterson is a research agronomist with the National Capital Region of the National Park Service.

Making Fall Leaves Work All Year Round

A different composting system is employed in Rock Creek Park in Washington, D.C. The park is the recipient of the fall leaf collections from a major part of the nation's capital. Other organic material, like paper, wood chips, grass clippings, sewage sludge, etc., is always available. The large leaf piles are used to make a simple composting system for use in the park.

Pests: Controlling a Potential Enemy of Natural Resources

by George Mahaffey

Any park or recreation area devoted to visitor safety and enjoyment and the preservation of natural resources inevitably beomes enmeshed in pest management and the problems it entails.

In speaking about pests, I am referring to any organism which diminishes the value of resources of interest to man. Generally speaking, the rule of thumb in any pest management program is the least is best. Pesticides should only be used where feasible alternatives are not available or acceptable.

In the past fifty years, we have learned a great deal about pest management, particularly chemical controls, mechanical and biological methods of control and their impact.

A half century ago, the entomologist S.A. Forbes noted: ". . . We commonly think of ourselves as the lords and conquerors of nature, but insects had thoroughly mastered the world and taken full possession of it long before man began the attempt. They had, consequently, all the advantage of a possession of it long before man began the attempt. . . . If they want our crops, they still help themselves to them. If they choose to take up their abode with us we cannot wholly keep them out of the houses we live in. We cannot even protect our very persons from their annoying and pestiferous attacks, and since the world began, we have never yet exterminated—probably we never shall exterminate so much as a single insect species."

Well, the insect is not the only pest presenting us with a challenge. We have learned a bit more about how to manage without exterminating a species. But, the constant battle is still with us.

Coping with the Problem

Strategies for developing pest management programs invariably differ greatly among federal, state and local park and recreation programs, depending on the purpose for which areas were established, and budgetary constraints. Today, there are a host of additional environmental considerations which extend well beyond the boundaries of any park which must be noted before any control decision is made.

Objectives

The basic objective of any pest control program is to eliminate or reduce adverse effects on park visitors and park resources due to the presence of culturally or ecologically undesirable organisms in a park. The experience of the National Park Service in this regard is pertinent to pest management problems at any level. The following areas of protection of particular interest to the Park Service in its pest management program relate to any natural area:

Tree and shrub protection: The largest portion of pest control activities are devoted to protecting shrubs and trees from disease, insect infestations, and to a lesser extent, from damage by rodents and other animals. Natural vegetation and ornamental plantings near public

areas are of primary concern. If an outbreak of a plant disease or insect infestation occurs in a natural ecosystem of a park, the general policy is to allow nature to take its turn unless it is the considered opinion of park officials that such a policy would be ecologically undesirable or unfeasible.

Public health and visitor comfort: The use of pesticides to accommodate the public health and visitor comfort needs of a park are confined to developed areas. This would include applications to control outbreaks of plague, arboviruses, Rocky Mountain spotted fever and other diseases detrimental to people. The bulk of pesticides used in this category reduce annoyance from mosquitoes and biting flies.

Site protection and restoration: In nonhistoric areas, pest control activities cover reducing the proliferation of weeds and brush in campgrounds and other public use areas, and the protection of objects such as picnic tables and fences from infestation by powder post beetles and termites.

Turf protection: To maintain turf grasses, pest control measures are taken to control weeds, insects, and lawn diseases. Earthworks may also require special attention.

In sum, the Park Service's policy regarding pest control of native insects and diseases existing under natural conditions in the park's ecosystem is to let them run their course and exercise control only to:

- prevent the loss of the hosts or host-dependent species from the ecosystem;
- prevent outbreaks of the insect or disease from spreading to forests, trees, other vegetative communities, or animal populations outside the area;
- conserve threatened or endangered, or unique plant specimens or communities (see article on Endangered Species, this issue);
- insure public health and safety; or
- conserve and protect flora and fauna in developed zones.

In historic zones, particular attention is given to preserving, maintaining or restoring the historical integrity of the area.

Although there is a general "hands-off" policy regarding wilderness areas, when management feels it must step in to save a species or preserve an area, preference is given first to biological methods of control (see below), then to mechanical methods (see below) and finally, to chemical pesticides.

Chemical Pesticides

Because of the concern over the environmental impact of chemical pesticides, special care is given to their use. Fungicides, rodenticides, insecticides and herbicides are all used, depending on the situation. These may be applied via injections, soil integration of granular pesticides, soil drenching with liquid pesticides, broadcast spraying, topical spraying fumigation, vaporization, dusting and fogging.

There is a fine line which must be addressed in any policy formulation regarding chemical pesticides—essentially, one has to decide whether the cure will harm the patient more than the disease. The Park Service makes every attempt to reduce pesticide usage for the management of exotic biota, *unless* it is determined that the specific exotic species will cause more damage to park resources than the pesticide.

Note: Park managers may wish to read the Environmental Protection Agency's *Guidelines for the Disposal of Small Quantities of Unused Pesticides* (EPA 670/2-75-057) before disposing of original pesticide containers. A check of occupational health and safety regulations is also advised before using any chemical pesticide.

Biological Controls

Using parasites and predators is a more natural means of suppressing pest populations. Today, the main biological control is the use of *Bacillus thuringensis*, for the control of Japanese beetles.

The great value in using biological controls is that one may eliminate the need to use chemical pesticides entirely. Excellent results have been obtained by introducing parasite and predators of important pests such as the cottony cushion scale Comstock mealy bug, the Japanese beetle, and others.

The use of microorganisms—bacteria, fungi, viruses, protozoa and nematodes, under natural conditions, is successful largely because these organisms are usually highly specific against certain insects, so their adverse effects on the entire ecosystem is kept to a minimum.

Mechanical Controls

Today, mechanical methods are most commonly employed for weed control. Tillage is used to directly destroy weeds or to physically alter their relationship with the soil. Weeds may be topped, torn into parts, or forcibly removed from the soil, thus reducing their regenerative ability. Mowing and cutting, not generally thought of as pest control activities, do in fact, cut down on weeds. Frequent mowing favors the proliferation of more desirable grasses and reduced populations of many broad-leafed weeds.

Drainage canals and other aquatic environments could benefit from weed control by power shovels, draglines and dredges. Smothering is another mechanical practice used for weed control. Heavy mulches of straw, sawdust, bark, wood chips, gravel, and other organic and inorganic materials can be employed to prevent the establishment and growth of weeds.

Technology is only beginning to explore the use of mechanical methods for pest control. Studies underway include research on the response of different insects to various wavelengths of visible and invisible electromagnetic radiation, the use of sound, wind currents, barriers, and other non-chemical means of controlling insects in livestock buildings.

All these things sound ominous as man "tampers" with nature to provide a balance that makes it possible for him to enjoy nature. Clearly, any pest management program must be undertaken with an eye on the long-range effects of any action as well as the short-term rewards. Without a carefully considered pest management program, however, our parks might well become invaded by exotic biota, our historic resources eaten away by insects, and our visitors discouraged from entering many parklands because of mosquitoes, poison ivy and other pests.

Mr. Mahaffey is a resource specialist with the Natural Resources Management Division of the National Park Service.

Natural Fire in Yellowstone National Park

by Don G. Despain and Robert E. Sellers

Introduction

Maintenance of wilderness quality within the over 2,000,000 acres (809,400 ha) of natural environment is a major objective for management at Yellowstone National Park. This natural area management concept simply means that all natural processes are allowed to continue with a minimum of interference by man. Man provides the means by which the park visitor of the present and future can enjoy this natural ecosystem.

Fires ignited by lightning certainly qualify as natural processes, but we have controlled these fires to the best of our ability since 1880. Man's interference with the natural role of fire in Yellowstone continued until 1972.

In 1972, Yellowstone began a program to allow natural fires to run their course in some 340,000 acres (137,598 ha) contained in two blocks of wilderness on the east half of the park. This initial program was well accepted by park visitors and was ecologically and administratively very successful. In 1974, work began on expanding these areas to include all portions of the park currently being managed as wilderness. A plan was prepared to allow natural fire to play its role in approximately 1,700,000 acres (687,990 ha) within the boundaries of Yellowstone National Park beginning in the fire season of 1976. An Environmental Assessment was prepared in 1975 and received final approval by early spring 1976. A cooperative agreement was then drawn up with Bridger-Teton National Forest where a similar plan is in effect for the Teton Wilderness. This agreement allows natural fires to burn across the common boundary if the fire is acceptable to the receiving agency.

The Plan

Under the plan, the National Park Service has the option of allowing some fires to burn and of suppressing others. The plan is flexible, permitting decisions to suppress, partially suppress, or not suppress individual lightning fires. These decisions are based on the cause of the fire and on very careful calculations of fire behavior probabilities under conditions existing at the time of ignition and projected conditions. *All man-caused fires are suppressed.* Lightning fires are assessed individually with the objective of allowing them to burn if circumstances provide protection for human life, cultural resources, resources outside park boundaries, public acceptance, etc.

The Test

The plan's latitude for decision making was given a thorough test during the 1976 fire season during which 29 fires occurred. Ten of these were man-caused and suppressed. Three of the 19 lightning-caused fires were suppressed—two immediately and one after five days. Three lightning fires, ironically occurring in one two-week period, fully tested the flexibility of the plan. Distinctly different management decisions were made on each fire. Following is a review of these fires in the order that they occurred.

The Arrow Fire

Lightning struck a 50-foot (15.2 m) spruce tree on the afternoon of June 29; ground fuels were quickly ignited. The fire was about half-way up an east facing slope, about 200 yards (182.9 m) west of the Mammoth-Norris road, between Obsidian Cliff and Roaring Mountain. Park visitors traveling this road prior to the July 4th weekend had an excellent view. The slope was well covered with mature spruce-fir and lodgepole pine and was separated from the road by rather extensive moist meadows. About 50 elk (cows and new calves) frequented these meadows daily. Snow had only recently melted from the slope, so ground fuel moisture was fairly high. Winds were light and temperatures were in the 60°'s (15.6°C). The fire apparently had little potential if weather conditions remained stationary, so the decision was made to monitor the fire closely and allow it to burn. By the end of the day, the fire had crept uphill on the ground, enlarging to approximately two acres (.81 ha) by 5 p.m. Two forestry technicians were monitoring the fire. A third was stationed on the road to interpret the scene and explain the natural fire program to the traveling visitors.

On June 30, the fire continued to smolder on the ground with low intensity and rate of spread. Occasional flaming occurred during the afternoon. Several visitors asked the forestry technician what the name of the geyser was. Most were surprised that action was not being taken, but were quite receptive to the idea of natural fire's function after it was explained.

On July 1, the fire increased somewhat in intensity, spreading slowly uphill (west) and northerly across the slope with moderate torching in the afternoon, burning about four acres (1.62 ha) by the end of the day. The herd of elk remained in the lush, green meadow below the fire throughout the afternoon and evening, giving park visitors a once-in-a-lifetime opportunity to easily view and photograph elk against a natural fire backdrop. The interpretive program was expanded to broadcast details of the fire to visitors via their car radios. Pamphlets explaining the natural role of fire were freely distributed; reaction by the traveling public was 100 percent positive. At one point, a family stopped to ask if that was a forest fire on the hill. Upon being told "yes" and that it was being allowed to play its natural role in the system, the mother expressed some dismay that nothing was being done about it. An explanation followed and about half-way through the father took over and finished the dialogue.

Many visitors needed only to be introduced to the idea in order to see several advantages of natural fire. Some were thrilled to witness such an awesome force in its natural state. A conservative estimate is that over 3,000 visitor contacts were made at the fire scene up to this time.

The morning of July 2 dawned clear, dry and warm. Visitor interest remained high. The herd of elk continued to graze and rest, showing little interest in the fire, which covered about five acres (2.02 ha) by 10 a.m. Southwesterly winds in early afternoon became stronger, creating some eddying effects on the east facing slope containing the fire; flare-ups and spotting began about 2 p.m. About an hour later the fire activity increased dramatically, burning intensely down to the meadow and spotting across the road to the east and into some forested areas adjacent to the meadow. This activity produced an immediate traffic snarl on the road, requiring adjustments to assure public safety. Spot fires were suppressed

and traffic was hastily moved on. The elk moved on to more peaceful surroundings. The main fire crowned out about 30 acres (12.14 ha) simultaneously but cooled down quickly so that very little flaming could be seen by 5 p.m. During these first three days, fire danger indices went from low to very high, and the outlook was for continued high burning indices.

All decisions on the fire up to this point had been made by the District Ranger and Fire Management Officer, as called for in the fire plan. After the events of July 2, however, the District Ranger and Fire Management Officer talked with other park management personnel to decide how the fire should be handled in the immediate future. This decision-making group is also within the scope of the fire plan and again illustrates its flexibility.

On the night of July 2, this board decided to begin suppression action on the fire. Firefighting crews were moved in during the night and following day.

Since this was a natural fire in a wilderness area, the rationale leading to the suppression decision was based on these facts:

1. Major powerlines were located on the north and east sides of the fire. These lines were about a mile (1.62 km) away but the fire would probably reach them within a few days. Disruption of power service to visitor use areas of the park on a holiday weekend would be a major problem.
2. The fire was close enough to the road to cause continual traffic problems as it moved in a predicted northerly direction through fuels on east slopes. Spot fires near the road, together with smoke drift, could be expected almost daily.
3. Public opinion had been very positive. Acceptance of the program was complete at this time. Would it tend to diminish as traffic inconveniences occurred?

Alternatives discussed were:

1. Allow the fire to continue.
2. Allow the fire west of the road to continue. Suppress all spot fires east of the road.
3. Allow the spot fires east of the road to continue. Suppress all fire west of the road.
4. Allow the fire to burn until it posed a more immediate threat to the powerlines.
5. Suppress the fire immediately while it was relatively easy.

When alternative number five was agreed upon, Fire Management presented the Fire Boss with a suppression plan with a new and different twist, calling for complete suppression and mop up using a maximum amount of water and minimum amounts of trenching and cutting. The intent was to attempt suppression of the main fire with an "environmental line," or no visible fireline at all. A helicopter bucket would be used to cool off hot spots along the fireline. Spot fires were to be routinely lined by handtools.

The plan was in full operation on the morning of July 3. Water was only available for pumping from a small stream near the meadow areas below the fire, so the stage was set for our hydraulics wizards to test their skills. The various crews ready to go on the fireline were receptive to the plan. Within two days, water was available to all points on the perimeter. The environmental wet line was a successful reality by the end of the shift on July 4. All smokes on the fire were out on July 11. Throughout this period, fire danger remained high to very high and no precipitation was recorded.

We do not wish to detract from the value and usefulness of standard firefighting techniques used to protect commercially valuable resources. On the other hand, when suppression becomes necessary in places where a natural setting is to be preserved, some innovative techniques may be called for; different standards may apply. Impacts of suppression activities should be fully recognized and weighed against the impact of natural burning.

The Straight Fire

On July 11, 1976, as work on the Arrow fire came to a close, another lightning ignition took place about one-half mile (.8 km) north of Grizzly Lake on the upper one-third of an east slope. Fuels were mainly subalpine fir, spruce, and some lodgepole pine interspersed with green meadows. This fire qualified as a natural fire in a wilderness area, but was again located in a southwesterly direction from the same major power line that affected decisions on the Arrow fire. For this reason, an immediate decision to suppress was reached at the district fire management level. At the time, the fire crowned and before the full complement of 24 smokejumpers and helitack could get in position, it had run over the hill and down the west side between Straight Creek and Winter Creek. Five loads of retardant and 35 firefighters finally achieved containment on July 12. The fire burned 20 acres (8.1 ha). Hand line was used exclusively to affect control.

The Divide Fire

Lightning struck on July 11 on the west side of the South Arm of Yellowstone Lake starting the Divide fire. Contrary to the other two fires, this one was located in a very remote area, clearly visible from the South Arm of the lake but rather inaccessible from the ground. It did not threaten any developments other than backcountry campsites that could be closed. The decision on this one was easy—it would be allowed to burn. The fire was monitored on the ground until July 13 by two forestry technicians. The fuel type here was predominately Engelmann spruce and subalpine fir with large areas of lodgepole pine on the east and north sides where a fire had burned in 1879. The fire started in spruce-fir, which had not burned in the earlier fire. Fire danger was high and on July 14, the fire crowned out about 50 acres (20 ha) of spruce-fir during the afternoon. This performance was repeated on July 15 as the fire traveled in a northerly direction. On

July 16, the humidity dropped to 17 percent and 25 mile per hour winds pushed the fire southeast to the lakeshore, for a spectacular crowning run of about 600 acres (242.8 ha) during the afternoon. Interestingly enough, most of the run was made through the spruce-fir—the young lodgepole pine forest seemed to retard fire spread although 500-600 acres (202.4-242.8 ha) received numerous fire brands from the smoke column. This indicated to us that the 95 year old lodgepole pine was not yet ready to burn.

The fire burned intensely in the adjacent stands of spruce-fir. The reason fire did not burn into the lodgepole pine is not apparent in the usual statistical data. The difference in trees per acre is nonexistent. The dead fuel load differences do not appear to be the reason. There were more sound fuels greater than three inches (7.62 cm) in diameter in the spruce-fir stand (29.7 tons/acre vs. 6.4 tons/acre) (26.9 T/ha vs. 5.81 T/ha), more fine fuels (less than one inch (2.54 cm) in diameter) in the lodgepole pine stand (1.5 tons/acre vs. 0.6 tons/acre) (1.4 T/ha vs. .54 T/ha). Only the fine fuels are important in carrying fast moving fires.

There is a major difference in the species contributing to the fuels and a difference in age. This leads to differences not apparent in the above statistics. Lodgepole pine trees have coarse trunks and a thin canopy with the lower trunk self-pruning as the tree height increases. When a mature lodgepole pine falls over, relatively few, large, widely-spread branches remain. Fine fuels (less than one inch (2.54 cm) in diameter) are thus more evenly scattered on the forest floor. Both spruce and fir have a more compact growth form, with smaller needles and numerous small branches closer together. The lower branches do not self-prune. The trees in the spruce-fir stand are about 350 years old and have been accumulating branches all that time. The fruticose lichen *Alectoria* has also accumulated in the branches. Fire brands falling in a spruce-fir stand have a higher probability of falling into a large fuel bed which can produce flames that easily reach into the more flammable crowns of the spruce and fir trees. Enough wind will tip the flame into the next tree crown easily producing a crown fire. Accumulations of duff and rotten wood also increase the probability that the fire will last through unfavorable burning conditions.

Numerous fire brands were dropped into the lodgepole pine stands as evidenced by a large number of burned out, rotten lodgepole pine trunks. However, the fire did not spread beyond the trunk receiving the fire brand and those touching it. If this fire behavior results from the fuel characteristics just described and not from some unmeasured, unnoticed factor in the nonfuel environment, then natural fires may have a feedback mechanism on the frequency of fire on a given area. Information from the Divide fire also implies that for a unit of landscape, susceptibility to fire increases with time. Thus, continued fire suppression may increase both the area susceptible to fire and the probability that it will burn when ignited. This burning-frequency pattern will provide good opportunities for research efforts in the future.

The Divide fire remained fairly active in spruce-fir stands during the rest of July. The fire held at 1,400 acres (566.6 ha) during a comparatively moist August, but in September it smoldered through another 100 acres (40.5 ha) on the south end. The last smoke was observed on September 27 from the South Arm; the fire was declared out on October 10 after a snowstorm.

Summary

Since 1972, Yellowstone National Park has allowed a total of 36 lightning fires to run their natural course, burning a total of 2,300 acres (930.8 ha). Only seven of these have exceeded 1 acre (.4 ha) and only three have exceeded 100 acres (40.5 ha) in size. In 1976, three separate fires—all natural, all occurring in wilderness and all burning within two weeks of each other—provided effective tests of Yellowstone's Natural Fire Plan. Each fire was looked at individually with the overall objective of allowing fire to play a natural role in Yellowstone if circumstances present at the time would allow. The Natural Fire Plan is flexible; most of its options were applied during a two-week period. The plan allows natural fires to be completely suppressed from the time of discovery (Straight fire) to burn for a time and then be suppressed (Arrow fire), or to burn unsuppressed (Divide fire). The option to suppress only part of a fire while allowing the rest of it to burn is still untested. Above and beyond the specifics of a particular written plan, the need for such a plan is more important. In the long run it is often the scars of suppression activities that have the greatest adverse impact on a natural environment. If suppression is called for, perhaps we can devise new procedures to insure that suppression damage is minimized.

Much is yet to be learned about the role of natural fire in Yellowstone and how the ecosystem interrelates with it. The fires are providing many research opportunities and are bringing out relationships not thought of before, especially regarding lodgepole pine. With continued public support, fire may be permitted to play its natural role to a larger extent. The discovery of these relationships will continually enhance our understanding and appreciation of the total Yellowstone ecosystem.

Editor's Note: The above article will be included in the summer issue of Western Wildlands *magazine devoted to fire management. For copies of the upcoming issue write: editor, Western Wildlands, School of Forestry, University of Montana, Missoula, Montana 59812.*

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An Interagency Fire Center at Boise

The Boise Interagency Fire Center has been in existence since 1965. The present Center was dedicated in 1970. It is a unique cooperative venture between five federal agencies, working together to provide support to fire suppression activities all over the nation. The five cooperating agencies are the Bureau of Land Management of the Interior Department; the Forest Service of the Agriculture Department; the National Weather Service of the Commerce Department; and Liaison Officers from the National Park Service and the Bureau of Indian Affairs. In addition, the Boise National Forest maintains a Smokejumper Base and an Air Tanker Base on the Center. The Interior Department's Office of Aircraft Services has its offices on the Center as well. While physically located on the Center, these two agencies are not part of the BIFC organization.

The Interagency Fire Center was established in Boise because of the city's modern but relatively traffic-free airport, and because of Boise's central location. A great deal of the fire activity in this country takes place in the 11 western states and Alaska. Large fires are not confined to the West, however, as evidenced by the fact that there have already been major fires in Minnesota and South Carolina this season — and BIFC has provided help to both.

The main mission of the BIFC is to provide logistical support to fire management and fire suppression activities throughout the United States. When federal and state fire control agencies in particular locations have exhausted their fire suppression capabilities, BIFC ships men and supplies from areas of less fire danger to where they're needed. The agency occasionally goes international, providing assistance to our neighboring nations, Canada and Mexico. It is from this mission that BIFC gets its informal motto, "You Call, We Haul."

In conjunction with this mission, BIFC undertakes training and training development and testing programs in the agencies located on base. A program designed to standardize fire equipment and training between federal agencies is being developed by BIFC. The Center also provides an inspection and contracting program for federal agencies involved in fire activities.

The National Weather Service maintains its Idaho State Forecast Office at the Center. In addition, the Weather Service provides a number of fire weather forecasters — meteorologists who assist all the agencies on base by determining the affect weather will have on the fire outlook everywhere.

Aircraft play a vital role in the operations of BIFC — performing tasks that range from dropping chemical retardant on fires to slow them down, to transporting firefighters and their equipment to large "project" fires anywhere in the country.

Natural and Cultural Resources Management: Elements of Compatibility

by J. Robert Stottlemyer

All too often park managers find there is a real clash between the interests of those involved in natural resource management and cultural resource management. Frequently, the word "compatibility" has been better termed "combatability."

At the federal level alone, there has been a fascinating history and evolution of legislation emphasizing the conservation and preservation of our natural and cultural heritage. The first step was the 1872 Yellowstone Act, a broadly worded mandate casting the die for much subsequent conservation and preservation language. In 1897, the Forest Management or "Organic Act," of the U.S. Forest Service was another early compromise between strong advocates of conservation, and people in the west whose very livelihood was threatened, should a strong reservation policy become established.

In 1906, the Antiquities Act, signed by Teddy Roosevelt, created the system of national monuments — areas recognized for their outstanding natural and historical (archeologic) resources. In 1935, the Historic Sites Act clearly outlined the responsibilities of the Department of the Interior in historic preservation, and authorized a national survey of sites of outstanding significance. The result was the National Historic Landmarks Program, carried out by the National Park Service.

In the 1960's and '70's, a plethora of environmental legislation was written at the federal, state and local levels to ensure the consideration of our national heritage in the decision making process. At the same time, the National Historic Preservation Act of 1966, expanded the 1935 mandate and promoted federal interest in historic preservation to state and local holdings.

The capstone in the evolution of environmental legislation in this country was the passage of the National Environmental Policy Act in 1969. It was a declaration of national policy designed to ensure some degree of harmony between man and his environment. It required environmental considerations in the federal decision-making process, and required public review and disclosure of these considerations through preparation of an environmental impact statement. Most importantly, it spelled out the responsibilities of the federal government to use all practical means at its disposal to ensure the nation may "preserve important historic, cultural, and natural aspects of our national heritage, and maintain . . . an environment which supports diversity and variety of individual choice; . . ." In essence, the Act was our environmental bill of rights.

There has never been any legislative mandate which separated the objectives of natural and historic resource management, yet, the expertise of the people involved in these two disciplines, and their training, often builds in a common tension.

Let's step back and look at the development of the American attitudes toward natural and cultural resource management:

One only has to read the accountings of George Washington in western Pennsylvania in the middle 18th century, and of the exploration and opening of the middle west and far west to see clearly that man interpreted his environment then as something to be feared. The American Civil War considerably stimulated our technological capacity and ability to exploit our surroundings. In the decade

shortly thereafter, with the significant assistance of recent immigrants, much of the Great Lakes area was harvested of its most valuable timber. Millions of acres were significantly disturbed with slash debris left on the ground.

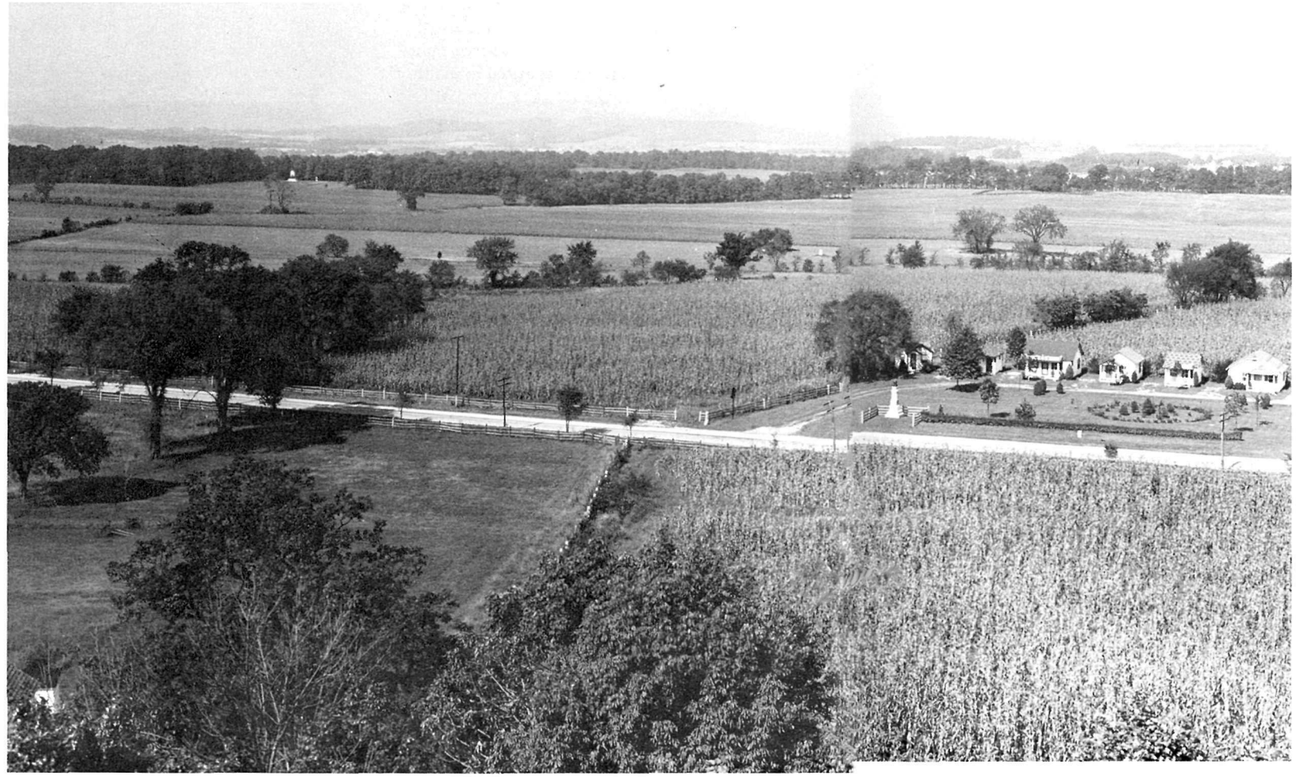
This provided an ideal substrate for holocausts such as the Peshtigo, Wisconsin fire of 1871 burning almost 1.5 million acres (607,050 ha) and consuming 1500 lives. Then followed man's obsession to control fire completely forgetting that fire had been a component of the environment for literally hundreds of millions of years. Thus began the extremely expensive practice of fire suppression.

With the expansion of man and his domestic livestock into the west, came the confrontation between man and natural predators. The nearly complete elimination of the mountain lion on the Kaibab Plateau prior to World War I, and the resulting disastrous overpopulation crash of the Kaibab deer was the end product. It was not until the decades of the 1920s and 1930s that anyone challenged the policies of fire suppression. In addition, one individual, working in Yellowstone, began to challenge Park Service policies on predator control.

Interest in Preserving Historic Resources

I am somewhat harder pressed to present an explanation on the evolution of this country's interest in preserving its cultural heritage. As was our attitude toward the natural components of our environment, there appears to have been a general lack of interest in the preservation and management of our cultural heritage until the early 20th century. This interest was certainly stimulated by the passage of the 1906 Antiquities Act. And it would be unfair to ignore the early explorers such as the geologist, John Wesley Powell, who not only mapped the geology of the Colorado River drainage but also spent considerable time studying and meticulously recording facts about the Paiute Indians.

It is perhaps true we had to achieve a certain degree of wealth or even maturity before we could recognize the value in recording and understanding the events



and artifacts produced by our predecessors. Also possibly relevant is the fact that the historian was trained, unlike the scientist, in the use of deductive logic. Until recently there did not seem great interest in taking meticulously recorded historical information on people and artifacts and expanding this into theses on the circumstances under which people lived. But the archeologist, trained as a scientist in the use of inductive logic, did dwell to a considerable degree on interpreting these findings and expanded his facts to explaining the circumstances under which people lived in earlier times. The archeologist was one of the first true human ecologists. Unfortunately, up through the early part of the 20th century the archeologist found little interest in studying relatively recent North American history. Prior to World War I, American archeologists knew a lot more about the Aztec and Inca nations than they knew about the 17th century natives of North America.

In recent decades, this situation has shifted dramatically. Quantitative historians are being trained and archeologists, working on sites such as the Makah Fishing Village on the Olympic Peninsula and in Colonial Williamsburg, have greatly expanded our understanding of the circumstances and impact of the environment on American society's one, two, and three centuries ago.

It is interesting to philosophize on the circumstances that might have promoted the attitude among many that natural and historical resource management cannot be obtained through mutual objectives. Complicating the management of natural and cultural resources has been the nature of resources making up many individual units of the National Park System: the outstanding natural and cultural resources of Mesa Verde National Park, the cultural and natural resources of Bandelier National Monument — both of which are being significantly impacted upon by an exotic burro population, the natural values of Cumberland Gap National Historical Park, the natural resources of Jamestown National Historic Site, the natural values of Gettysburg National Military Park, and the spectrum of cultural resources outlining the entire history of the early coastal defenses of this country on our barrier island national recreational areas. The administrative designation of a park area, be it a natural area, national park, historic site, or recreation area, clearly is not the common denominator needed for resource management. Not only are the resources diverse within a given park unit, but it is not uncommon for them to be of nearly equal national significance.

To encompass the diversity of resources and their management within the National Park System, the Park Service in 1975 developed management policies based upon resource classification or zoning. Furthermore, land classification would consider as a primary factor the nature of the resources present. This approach greatly simplifies the problem of developing resource management policies and objectives for different park units. Finally, there is the common denominator among various administrative units of the National Park System for management of their resources, that being resource suitability (see article on Land Use Planning, this issue).

Seeking a common denominator in the management of resources began before 1975. In 1973, there was an evaluation of both the existing guidelines, for historic and natural resource management plans. Considerable overlap existed in terms of information requirements, management approach, objectives, and manner in which planning requirements were incorporated into programming and budgets. The result was that several Park Service regions began considering the management of historical and natural resources where they occurred in one park unit as two chapters of the same resource management plan. Another direct benefit has been the development of a similar strategy for solving resource management problems identified in planning. By considering resource management by land class, taking into account the basic constraints and attributes of the resource for given uses, providing the rationale for existing practices, developing arguments for what additional activity or study is needed to meet the resource management objectives for each land class, one has about an objective a basis as possible for quantifying needs for programming and budgeting.

Another equally important appreciation yet developing in the management of natural and historical resources is the natural role of both scientist and historian in successfully managing a common resource. Some examples might clarify this.

The Park Service manages numerous areas where significant events took place during the War for Independence and the Civil War. Many parks contain earthworks. The attempt is to keep these earthworks intact as long as possible while recognizing that all are gradually eroding. The only feasible manner to maintain them is through sophisticated vegetation management to sustain a durable, maintenance free, ground cover. It is a case where good natural resource management is the only feasible way to carry out the primary objective, maintaining the historic scene, of major historical parks.

A similar resource management issue is present at Gettysburg National Military Park — recreating the historic scene. Like most historical park areas, funding levels will never permit a complete recreation of the scene as it was those fateful days of 1863. Since then, farm boundaries have changed and forests have encroached much acreage open at the time of the Civil War. Once the suitability of park lands for forests, or agricultural purposes has been determined, this can be quantified into what it will cost to reestablish the scene. The park manager, with input from the historian, can then know where and how he might most efficiently apply his funding to reestablish a given condition. Historic preservation funds go a lot further when one is not fighting the natural system.

One could provide other constructive examples of both where the objectives of natural and historic resource management are alike and where both must be considered for success in meeting a given park's objectives. But I think the key in resolving what might be at times dichotomous, competitive resource management programs in any agency is the use of objective bases in the planning and programming process. For land managing agencies like the National Park Service, the primary purpose and compatible secondary purposes of any given park area must be established as resource suitability. The quantification of resource attributes and constraints, regardless of the park's administrative designation, is the only manner in which to project in the programming and budget cycle the funding required to successfully carry out the mandates of a resource managing agency.

Dr. Stottlemyer is the chief scientist of the Mid-Atlantic Region, National Park Service.

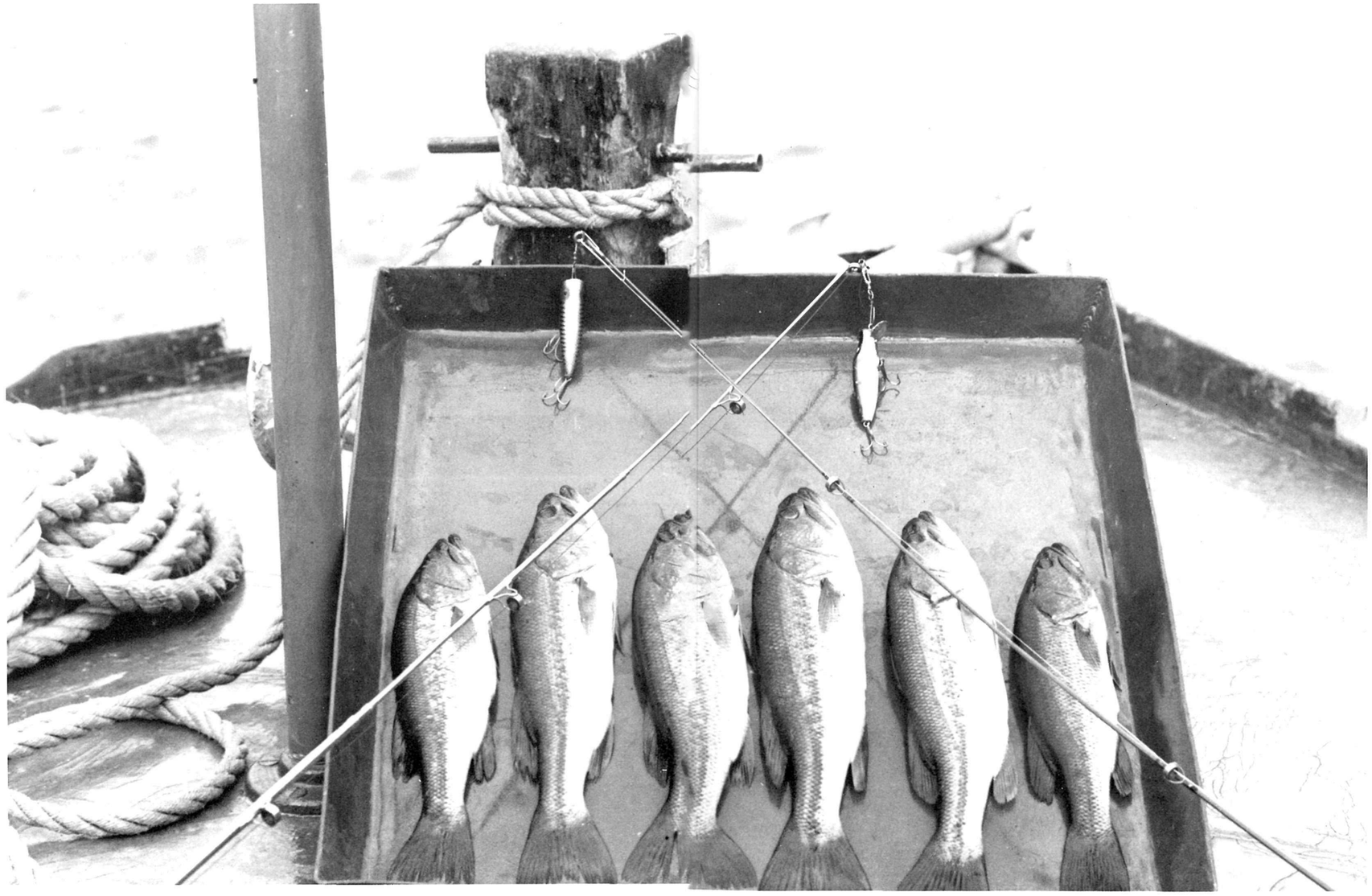
National Park Estuarine and Coastal Marine Fisheries Management

by Gary E. Davis

Fishing is killing. Fishing consumes natural resources. Fishing is encouraged in National Parks. Why? Timber and ungulate herds are no less "renewable" than fishery stocks, yet timber harvest and hunting are prohibited in almost all parks while both recreational and commercial exploitation of fishery resources are standard park uses wherever fish are found. This attitude toward fishery resources creates a paradox for park managers whose primary objective is maintaining maximum species richness in natural ecosystems. While trying to preserve all of the processes and species in park ecosystems on one hand, they are encouraging selective removal of generally high level predators from park aquatic systems on the other. There are several significant effects of fishery harvest on park ecosystems that must be recognized if the conflicts between park management and fishery harvest are to be satisfactorily resolved.

Probably the most commonly recognized impact of fishery harvest is the direct removal of fish. In a park system, human removal of fish represents direct competition with natural predators for both prey, and in many cases, space. The disturbance from nesting and fishing sites of fishing birds such as bald eagles and ospreys by fishermen in high powered boats represents acute competition for space in a world already severely cramped. Human harvest, particularly by recreational fishermen, is significantly different than harvest by "natural" predators. First, fishermen completely remove their catches from park ecosystems, rather than "recycling" the biomass within the system as do other predators. Secondly, sportfishermen, as predators, do not exhibit the same density-dependent relationship with prey species as do natural predator-prey populations.

Because of the aesthetic attractions of park wilderness, fishermen will continue to seek and remove fish long after it ceases to be economically feasible to do so in terms of energy expenditures. This situation increases the probability of serious reproductive stock depletion beyond that normally experienced in natural systems. When an eagle no longer receives more energy from a particular fish than he expended in catching it, he shifts his attention to other more abundant species or other areas, or dies. Sportfishermen may complain that a formerly rich site seems to be "fished out."



It has been demonstrated in relatively simple marine systems that removal of a dominant predator causes a shift toward a simpler food web with fewer species. Fishery harvests are generally composed of top level predators. Fishing is highly selective for just a few species. In Everglades National Park, over 85 percent of the sport harvest consists of just four of the more than 250 species of marine and estuarine fishes found in the park. The selective removal of these predators by fishermen may significantly change the food webs and trophic structure of the ecosystems in which they are found. This is exactly the problem park management seeks to avoid in preserving maximum species richness. Even with apparently severe restrictions, sportfishermen can effectively remove significant proportions of a target species.

At Dry Tortugas, Florida, in Ft. Jefferson National Monument, recreational divers and bully netters were limited to two lobsters per person per day for an eight month season. *During that single season, 58 percent of the population was removed, and with natural replacement, it will take over three years for the population to recover.*

Fishery Resources: The Effect of Outside Ecosystems and Influences

Fishery populations do not exist in a vacuum. They are integral parts of park ecosystems. As such, they are subject to anything affecting those systems. Alterations of watershed habitat by fire, manipulation of freshwater runoff into coastal estuaries, and disruption of submerged habitat by boating activity, can all cause significant changes in park fisheries. These ecological disturbances are usually subtle and difficult to detect.

Again using Everglades as an example, we found that while the annual volume and quality of freshwater flow into park estuaries remained unchanged, changes in the seasonality of the discharge apparently reduced its effectiveness in flushing, mixing, and diluting the estuaries. As a result, there was an increase in estuarine salinities, accompanied by increased abundance of mature gamefish, and a corresponding decline in estuarine nursery area. So while fishing improved, production of the juvenile gamefish for next year's fishing and the shrimp to feed this year's crop was reduced. The short-term gain of temporarily better fishing will surely be outweighed by the long-term irreplacable loss of nursery habitat and subsequent loss of fishery recruitment if this situation is not rectified. The first step in managing park fisheries is recognizing and defining these kinds of problems.

In South Florida, the National Park Service manages virtually the entire coastal zone from Miami on the east coast around the tip of the state to Marco Island on the west coast. Park Service responsibilities include not only 900,000 acres (364,230 ha) of estuarine and coastal marine habitat, but also over 1,200,000 acres (485,640 ha) of adjacent freshwater marsh and watershed. These ecosystems support most of South Florida's fisheries, both as nursery grounds and breeding adult habitat. Pink shrimp, spiny lobster, stone crab, blue crab, mullet, snook, red drum, spotted seatrout, gray snapper, bonefish, and tarpon comprise the vast majority of this fishery, and they all rely on the continued existence of the natural, park-protected, estuaries and coastal waters for their survival. These fisheries and the tourism they support are major economic factors for the entire region.

To effectively deal with the park management-fishery harvest paradox, a delicate, dynamic balance must be struck between the two conflicting objectives. This requires a considerable amount of accurate, timely, and regularly updated information about the needs and conditions of park ecosystems with respect to fishery resources and harvest.

The need for fishery data from Everglades National Park was established as early as 1935. At that time, the National Park Service was committed to managing the fishery resources of Florida bay and the mangrove-lined estuaries along the southwestern coast of Florida within the park. Four years after the park was established in 1947, the first special regulations concerning fisheries management in the park were promulgated, but it was not until 1958 that any systematic effort was made to collect the basic data necessary to monitor the fisheries to determine whether or not the management goal of "sustained yield" was being achieved. For ten years, from 1958 to 1969, investigators from the nearby University of Miami, principally James B. Higman, conducted surveys of fishermen at Flamingo, Florida. These National Park Service-supported studies are the foundation of the present fisheries data collection program.

Collection of Fishery Data

Since 1965, all commerical and guide fishermen fishing in the park have been required to obtain a no-fee fishing permit from the Superintendent of Everglades National Park and report their catches to him as a condition of the permit. These catch data consisted of total monthly catches, by species, for each fisherman. Unfortunately, these catch reports did not include any measure of fishing effort, so that it is not possible to monitor population levels from them.

Fishery scientists have been using catch per unit of fishing effort techniques to monitor the relative abundance of fish populations since the 1890s, but most large-scale fishery statistical systems do not collect or report an effective measure of fishing effort. Furthermore, catch statistics for recreational marine and estuarine fisheries are not conveniently acquired, and until recently, sport harvests have apparently not been considered significant impacts on these resources. For these reasons, the routine procedure of reporting only total commercial harvest does not provide the basic information necessary to effectively understand and manage the mixed recreational and commercial fishery in Everglades National Park on a sustained yield basis.

The program currently in operation at Everglades and Biscayne National Monument provides both accurate estimates of total harvest for the major sport and commercial fisheries and yields catch rate estimates of fish availability with sufficient precision to permit evaluation of seasonal fluctuations. It also provides accurate estimates of boating and fishing activity. Development of the present data acquisition program began in 1972. Its primary aim was to improve the precision of catch rate estimates and measures of fishing effort for both sport and commercial segments of park fisheries. It also standardized all fishery data collection and provided real time quarterly reports which included estimates of total harvest and fishing effort in the park.

In conducting early surveys, it was found that the variability in sport fishermen's catch rates at Flamingo was so great that you could not collect large enough samples to detect population changes in all but the two most abundant species in the sport fishery, except on an annual basis. A detailed stratification of the fishermen and refined measures of their fishing effort were added to alleviate this problem. Fishing effort parameters were added to commercial and guide fisherman catch reports.

At the present time fishery data are collected and reported routinely, just as standard weather information or visitor use figures. Fishery data are collected and summarized in five categories: (1) boating activity, (2) sport fishing, (3) guide fishing, (4) commercial fishing, and (5) stone crab trapping. Six standardized reports are produced from these data: (1) weekly sportfishing activity, (2) monthly boating activity, (3) quarterly sportfishing, (4) quarterly commercial fishing, (5) annual sportfishing, and (6) annual commercial fishing. Used in conjunction with computer programs, developed by the National Park Services's Division of Data Systems in Washington, D.C., this data acquisition program provides resource managers with the basic information they need to evaluate their management actions and other factors influencing the fishery resources in the park.

Results

A brief summary of the results of this program at Everglades National Park shows that during each of the last four years 12,000 to 15,000 sport fishermen were interviewed, and 2,000 to 3,000 catch reports were submitted by professional guides and commercial fishermen. Analysis of these data gave annual harvest estimates of about 1.5 million kilograms (3.3 million lb) by 150,000 recreational and 250 commercial fishermen from a 3,000 km (1,200 mi^2) area in Everglades National Park. With the notable exception of the stone crab fishery, none of the major species shows signs of overfishing. However, the effects of disrupted fresh water flow into park estuaries was apparent. Traditionally hyposaline estuaries showed significantly elevated salinities, and proportionately more mature game fish have been caught in recent years than were caught 15-18 years ago.

The trap fishery for stone crabs in the park has shown an alarming 80 percent decline in catch rate beginning in January, 1972, and extending through the '75-'76 season (measures of fishing effort were first collected in '72). Because the number of traps so saturated the area during this period, many fishermen quit fishing in park waters for most of the last two seasons because of economically unsatisfactory yields. The decline in the catch rate appears to reflect a significant reduction in stone crab stock in the park. An investigation of stone crab ecology and population dynamics is underway to establish and evaluate management alternatives to protect stone crab stocks in the park.

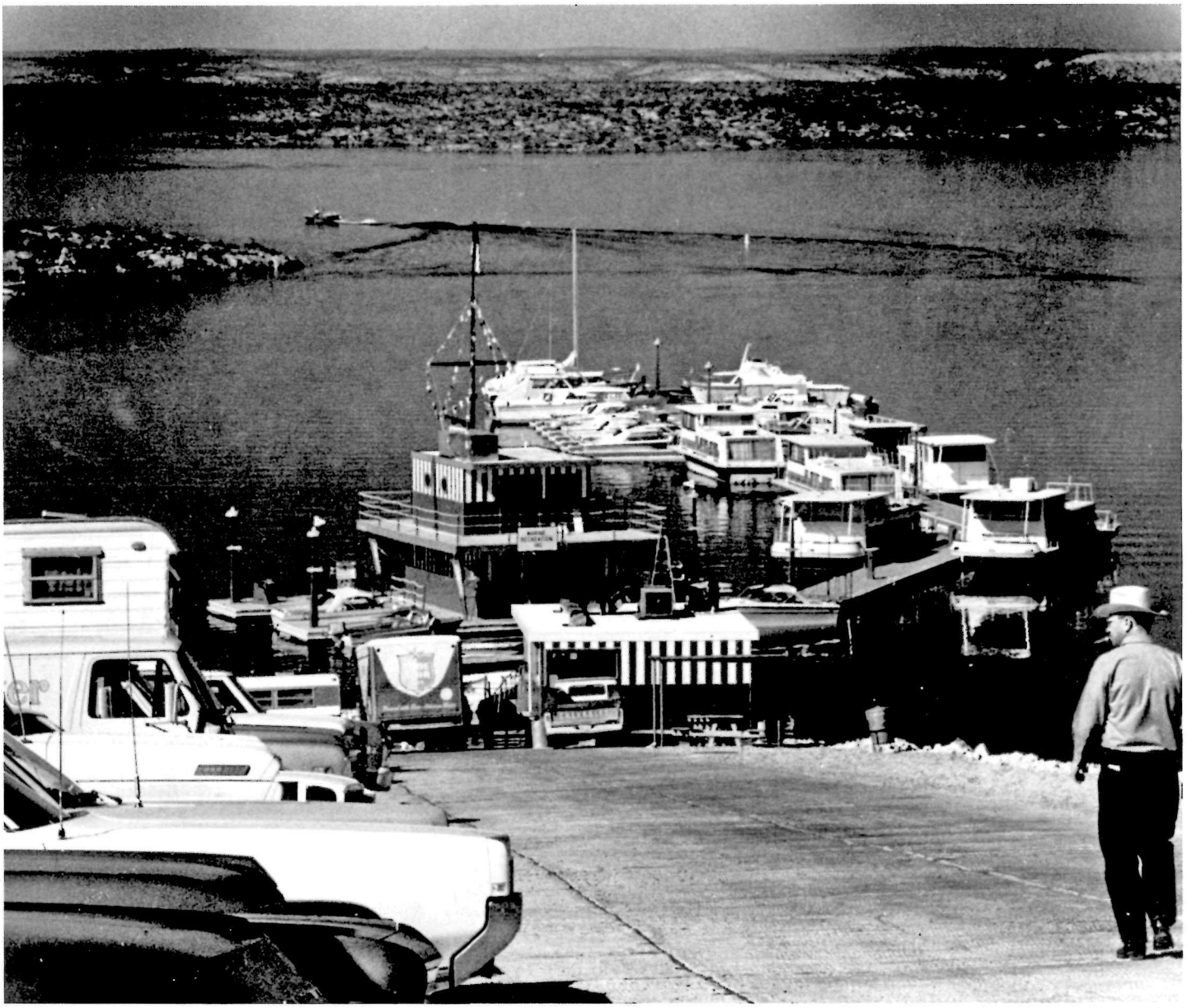
A feasibility study to establish an estuarine and coastal marine water quality monitoring program is also underway. It will review the historical data base and evaluate available technology for longterm water quality monitoring of the 3,000 km^2 (1,200 mi^2) coastal area of the park.

Sporadic water quality measurements have been made in the park by several universities, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and the National Park Service. These measurements were made in conjunction with specific studies at a variety of locations over the past 25 years. They provide useful background data, but they do not provide the continuous record needed to identify and relate long-term trends in biotic resources and water quality.

Future Plans

A comprehensive monitoring system for all marine and estuarine waters in the park will be designed and tested for efficacy. The system design will incorporate a combination of hardware, personnel, and logistic support that is cost effective and will also recommend sampling stations, frequencies, and parameters to be measured. Cost estimates for implementation, operation and maintenance will also be developed.

By combining the fishery data collection program described here with the forthcoming water quality monitoring network and indicated species studies, such as the stone crab project, we will be able to provide park managers with timely descriptions of park fisheries and identify alternative management actions to



optimize fishery yields. We should be able to reduce the park management-fishery harvest conflict and accurately predict the potential results of various environmental conditions and management programs on fishery resource. Already the program has identified specific areas of concern. Stone crab stocks have been severely reduced by fishery harvest, but the problem has been identified and remedial actions are being designed. The remainder of the fishery resources of Everglades National Park show no evidence of harvest-induced stress, but detrimental effects on these resources of watershed management practices have been identified, which is the first step in protecting them.

Excluding the aesthetic and recreational values of the park fisheries, the dock-side value of the harvest and the direct expenditures of the recreational fishermen place the annual value of the in-park fisheries at about $4.5 million. The value of extra-park fisheries directly supported by park nursery areas exceeds $35 million. The annual cost of operating this fisheries data acquisition program is about $20,000 less than, or 0.4 percent of the commercial value of the in-park fishery, a small price to pay for the resource protection afforded.

Conclusion

There is a distinct conflict between the goal of preserving the maximum species richness in our national parks and fishery harvesting within those parks. The apparent acceptance of fishery harvests within our national parks by the American people is rooted in a tradition and a social phenomenon with which park managers cannot effectively deal. To reduce the conflict, effective monitoring of fishery harvest and the population dynamics of fishery resources seems to be the best action. The information gained through this monitoring may be used to enlighten the public about the effects of fishing in certain areas so that the public can make an accurate determination about the "highest and best" use of its fishery resources in our national parks.

Mr. Davis is a marine research biologist with Everglades National Park.

A Computerized Accounting System for Backcountry Use

by Donald R. Field, Marisue Wells, and Robert Flewelling

Parklands are an attraction for millions of people each year. In the Pacific Northwest alone, 80 percent of the residents of Washington, Oregon and Northern California claim visits to public and private parks. Over half of these people visit National Park Service areas and approximately 15 to 20 percent use trail systems or are considered backcountry hikers (day and overnight users). Current predictions suggest that the number of people going to parks in the northwest will increase and the rate of parkgoing will continue to grow. Similar predictions are available for the backcountry.

Recognizing these projected trends, and in anticipation of potential pressures upon limited and sometimes fragile resources, park managers requested assistance from the National Park Service (cooperative park studies unit, University of Washington) in collecting information on human-use patterns in selected backcountry areas. To date, data collection efforts on backcountry users have involved trail surveys, interviews with non-permit hikers, human impact assessments, and assessments of backcountry use permit data provided by Mount McKinley, Mount Rainier, North Cascades, and Olympic National Parks. Using information gained through backcountry permits (the collection and processing is described below) we can identify some implications of this information for management.

Background

In the summer of 1973, a computerized system was initiated for processing backcountry use permits from North Cascades National Park. The purpose of the system was to provide summary information of backcountry use for management. The types of information obtained and the man-hours saved by going to computerized analysis to gather seasonal and yearly summaries, brought immediate recognition of the utility of this system.

In 1974, Mount Rainier, Olympic, and Mount McKinley National Parks were added to the project. A revised, more efficient and complex computer program was developed and put into operation based on meetings with Park Service management personnel who helped identify the types of output needed, increasing the system's practical utility. The experience demonstrated the importance of continued and regular interaction with resource managers in order to develop a computerized system to its full potential.

The Process

Several basic steps are involved in the preparation of information before it is stored on computer tape and available for analysis. The permits are prepared before or upon entrance of each party into the backcountry. The information to be computerized on the permit consists of:

- a code to identify the park in which the permit was issued,
- zipcode of the party,
- size of group,
- number of pack or saddle stock,
- starting date,
- ending date,
- entry and exit points to the backcountry, and
- a travel zone code consisting of the travel zones to be visited and the number of nights spent in each.

Additional information can be computerized such as, number of water craft, type of backcountry use, and permit issuing station (Table 1).

The permits are initially screened at the park and at regular intervals, sent by the backcountry permit coordinator at the park headquarters to the cooperative park studies unit (Sociology Studies Program) at the University of Washington, where the computer facilities are located. The permits are directly punched into IBM computer cards and verified. Cards are then run through the Data Setting Program, which performs several important functions in preparing the data for further analysis. Since the location of information on the permit varies from park to park the information is standardized and errors corrected. The data is stored on permanent magnetic tape files.

Once the data has been stored, the "Permit Information Program" can be run. These programs generate a package of nine data tables useful to management. The programs can produce sum-

Table 1

Tables Produced by Data Processing Program, 1976

1. Travel zone use
2. Entry and exit point use
3. Number of parties camping in national parks each night of year
4. Number of persons camping in national parks each night of year
5. Number of parties each week
6. Number of parties each night
7. Origin of visitors
8. Length of stay
9. Party sizes

**Cross tabulations of factors is often undertaken to add further explanation for events taking place in the backcountry, for example, the cross tabulation of length of stay with party size. The resulting information can provide an indication of the total person camping impact in the backcountry.*

maries of all variables alone or in combination for individual months, the entire summer, or the entire year. Slight variation in the program can produce tables for exclusively selected origins, travel zones, or entry points, or a specific segment of the public as identified by zip code. Additional programs can be developed which generate various graphs to display information. Graphs help facilitate communication with a nontechnical audience.

The Data Package

The initial table derived from permit data is a summary title page giving the total number of parties, people, and visitor nights recorded during the survey period. It aids managers in making a quick assessment of current use patterns which can be compared with previous years. Information is reported in Table 2 for the participating parks for a three year time period. Between 1975-76 northwest parks, for example, experienced an 8 percent increase in the number of permits issued and in total number

Table 2

*Trends in Overnight Backcountry Use Patterns for All Parks, 1974-1976**

Variable	Year 1974	Percent change 1974-1975	1975	Percent change 1975-1976	1976
Permits Issued (Parties)	17,087	27%	21,780	8%	23,524
Number of Overnight Hikers	54,942	16%	63,997	8%	68,858
Total Visitor Nights	151,290	7%	162,481	4%	168,999

**Information was not available for Mount McKinley in 1974, therefore the rate of change in use from 1974 to 1975 is overestimated. Between 1975 and 1976 when all four parks were included in the analysis, there was an 8% increase in total number of parties and hikers and a 4% increase in total visitor nights.*

of users; there was a 4 percent increase in total visitor nights.

The next set of information produced from permit data contain yearly frequency tables reflecting the distribution of use in a park by each day of the year, and each day of the week. This information allows managers to identify peak use periods, during which more intensive operations may be required. In addition, the assignment of maintenance patrols can be examined in terms of months and days or sets of days like weekends. Northwest parks received the greatest backcountry use on weekends. Hiring of seasonal backcountry rangers and timing for completing a summer staff can be guided by the above information. District managers can likewise assign backcountry patrols based upon daily weekend and seasonal patterns of use. The same can be said for assignment of interpreters to the backcountry.

All northwest parks are subdivided into zones. A travel zone table indicates how many people parties, and visitor nights, (expressed in absolute numbers and percentages) each travel zone received during the surveyed period. The same information can be reported for type of use within each travel zone. These data spotlight heavily and lightly used backcountry zones. And thus, such information is a useful guideline in management efforts to redistribute use throughout the park, including a redirecting of users from overused to less crowded areas of the park through trip planning, or establishing limits for overnight camping. Information on party type facilitates the planning of backcountry zoning that is designed to reduce potential conflicts between diverse hiking parties.

Conflicts might be avoided by zoning areas within the backcountry for such potential competing activities as fishing areas, horse use areas, shelter areas, etc. (see story this issue on land use planning for parks). A related point here is that the type of parties encountered may be as important to user perceptions of crowding as the number of contacts. Backcountry use data could aid in reducing conflicts between hikers and animal populations. In some cases, hikers can (intentionally or unintentionally) disrupt breeding areas and/or migration routes of various animal species. By providing information on the number of parties and hikers present in given travel zones during certain time periods, permit data can be used in decision making to avoid potential man-animal conflicts (see story on the Endangered Species Act this issue).

Table 3

*Place of Residence of Overnight Backcountry Users in Four National Parks, 1976**

Residence	Park (Percent) Mount Rainier (N = 5,027)	North Cascades (N = 2,976)	Olympic (N = 12,412)	Mount McKinley (N = 1,735)
Within State	72	72	75	45
Adjacent States and Northern California	11	11	11	20
Outside of Region	17	17	14	35
Total	100	100	100	100

**Data is compiled from backcountry permits received.*

An entry and exit point table displays how many persons and parties entered the backcountry at each trailhead during designated time periods, and the percentage of these parties that exited at the same or alternative points. Uses to be made of this table are similar to those of the travel zone table; but it also aids identification of points of congestion as well as hiking routes. In addition, the information could be helpful in determining the number of parking spaces needed near trail heads or for identifying transportation needs between distant entry and exit points.

Parks in the northwest are most often visited by persons residing within a geographical region, here defined as the Pacific Northwest Region managed by the National Park Service. As seen in Table 3 which is a composite picture derived from all permit data, upwards of 70 percent of the overnight hikers in Mount Rainier, Olympic, and North Cascades National Parks come from Washington. When we include the remainder of the National Park Service region, the percent jumps to 83 percent of the hikers reside within the northwest. A very different pattern is noted for Mount McKinley where only 45 percent of the overnight hikers reside in Alaska. When Mount McKinley's region is expanded to include the rest of the northwest, the population of hikers residing in a state or providence adjacent to Alaska increases to 65 percent.

Zip code, or comparable Canadian mail code by which residential information is derived, is a very useful piece of information on the backcountry permit. Awareness of users' origins from zip code data has allowed managers to more precisely pinpoint population areas which must be kept informed about public hearings on wilderness, soliciting public input on backcountry management plans, and where information to specific clientele groups on changes in regulations governing backcountry travel, and interpretive pamphlets, should be disseminated to reach likely park clientele.

The length of stay table provides a frequency breakdown of the number of nights spent in the backcountry by type of party. In the northwest the average length of stay in the four parks was 1.91 nights. About 84 percent of all overnight hikers spend between one and two days on the trail. A party size table gives a frequency distribution of the number of people in each party and when matched with the length of stay can provide a measure of camping impact.

Implications

A computerized accounting system for backcountry use has been operational for several years in both the National Park Service and the U.S. Forest Service. Its potential as a management tool, however, remains to be fully realized.

Our program is but one example of the use of computers in support of a management-operations function (i.e., backcountry management).

While several standard tables can be generated from permit data on origin, destination, information, party size, and frequency of use information, the system is capable of producing most outputs desired. The ultimate value of the system is in direct proportion to the completeness and accuracy of the information initially recorded on the backcountry permit.

The future of this computerized accounting system for backcountry use or a variation of it is in its utility for both management and research. The large storage capability of most computer systems would permit the inclusion of both management data currently collected by park operations (of which backcountry permit information is but one sample), and scientific information from ongoing park research activities. As a by-product of our work, we are experimenting with a data retrieval system which could contain bibliography citations of research products for a given park, management data on the backcountry, general visitation statistics and data obtained from biological-social science research.

As a final note, efficient management of parklands cannot be achieved without cognizance and understanding of management practices on adjacent lands. The backcountry again is a good example whereby clientele groups are shared between agencies. The ability to jointly plan for a backcountry system regardless of administrative boundaries associated with the backcountry can be facilitated by a common data collection system and maintaining a joint computerized data pool.

Editor's Note:

This article is a summary statement of the entire project. A copy of the final report will be available after July 1, 1977, and can be obtained upon request from the senior author. The project is jointly sponsored by the National Park Service (Sociology Studies Program) and College of Forest Resources, University of Washington.

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The Effects of a Drought on Natural Resources

Clearly, water is one of our most precious natural resources. When a drought threatens, the distribution and management of that resource becomes paramount. Right now, our western states are facing severe drought conditions. Secretary of Agriculture Bergland visited farmers to assess the impact of water shortages firsthand. The President, as early as last February, asked Secretary of the Interior Cecil Andrus for an assessment of the western drought, and many of the recommendations made by the Secretary are now being implemented.

Drought conditions offer insights into the problems we face as a nation in determining where to place our resources to achieve the greatest good for the greatest number of resources.

Water needs extend well beyond the normal, easily understood human consumptive needs. It is needed for irrigation, navigation, power, mining, industrial and commercial uses. In terms of natural resource management, water plays the central role in maintaining ecosystems. Streams and lakes require flows and volumes of water adequate to maintain fisheries and related aquatic flora and fauna, riparian vegetation, wildlife habitat and wilderness preservation. Beyond the preservation of many forms of life, water is a major source of recreation activities and an important ingredient in our aesthetic appreciation of the environment.

What happens when there isn't enough to go around? Fish and wildlife populations take a severe beating in drought-afflicted areas.

As natural wetlands and refuge impoundments dry up, waterfowl production drops. Refuge pools dry up and refuge crop fields cannot produce sufficient food. Thus, many park areas cannot cope with the large concentrations of wintering waterfowl accustomed to visiting their park. Waterfowl are subject to disease at a higher rate during drought conditions, particularly fowl cholera and botulism.

Concentrations of birds and animals near existing food and water supplies increase predation on nesting waterfowl and create competition for human food supplies. Water and forage for livestock are needed, as well as water for human consumption. Finally, diminished habitat and potential wildlife losses may concentrate eagles in vulnerable situations.

Fish, too, are more prone to diseases, and their production drops. For example, anadromous fish, finding it hard to move upstream, have difficulty breeding. Smolts find it difficult to move downstream.

Some Solutions to Fish and Wildlife Management in a Drought

Special grazing areas for livestock may have to be set aside for feeding. Hatcheries can build up their stock of fish to overcome the high anticipated mortality of fish in the environment. In areas

where anadromous fish exist, hydroelectric dams, where they occur, can be operated so that there is minimal damage to fish populations.

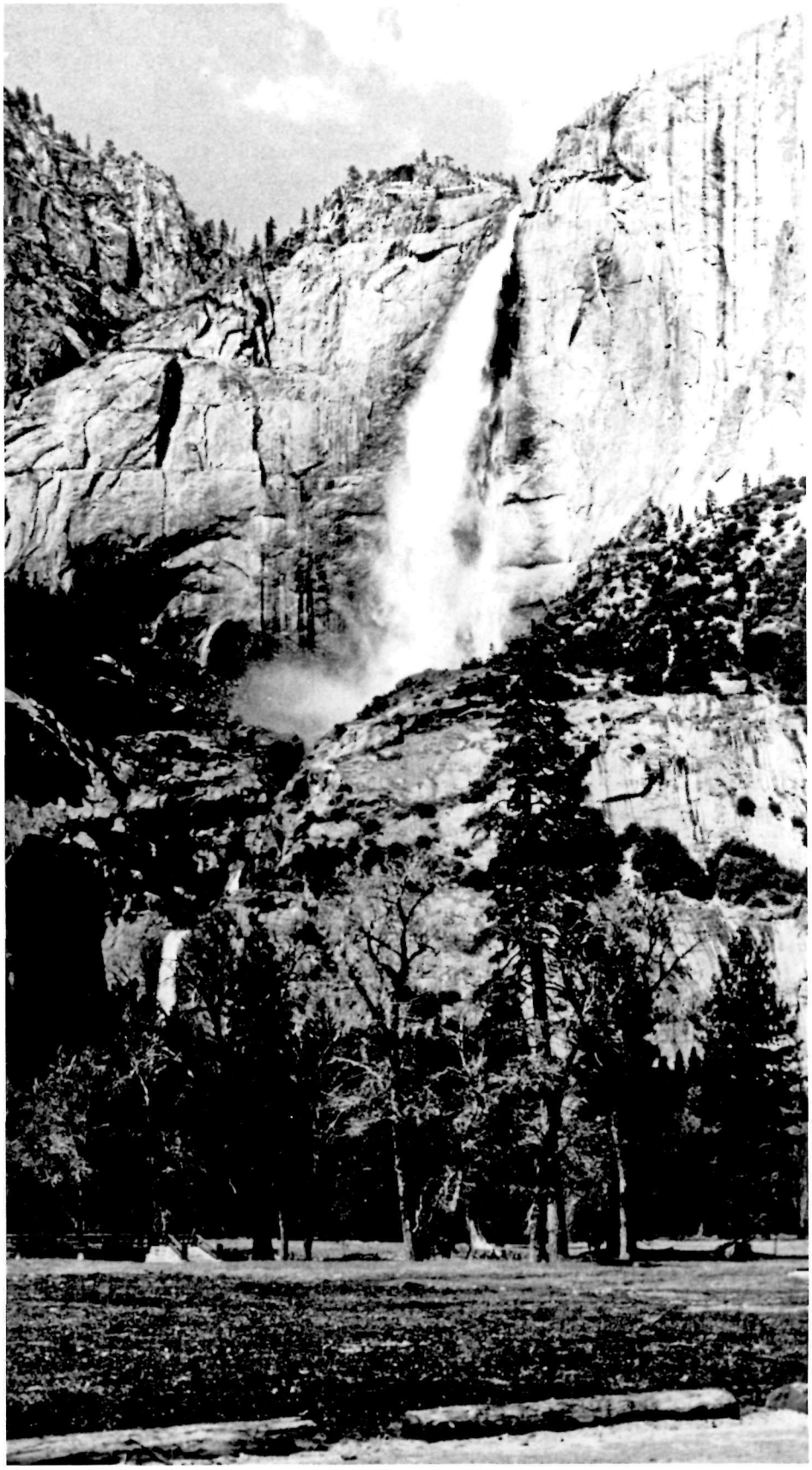
In areas where waterfowl populations are endangered, special measures may have to be taken to control the threat to their species. Scaring and feeding procedures might be adopted to protect crops planted for human consumption. In some instances, the habitat of certain species may have to be sacrificed during the drought and restored later as animals abandon their traditional homes in favor of more hospitable environments. Every effort should be made to restore the animal's habitat as soon as resources are once again available. Special supplemental watering alternatives may have to be adopted and in some instances, range animals may have to be rounded up to preserve natural areas and provide animals with sufficient food and water.

Fire Management

One of the most significant threats posed by any drought is fire. Whole areas become dry, highly susceptible to brush fires and major forest fires endangering whole ecosystems (see article on Fire Programs, this issue). A thorough survey of all fire-fighting equipment, from ground to air (large helicopters and retardant aircraft) is necessary.

Probably the most significant impact of a drought is that recreation areas may have to be cut back and the wilderness areas closed, should the situation become acute, to avoid any potential unwanted fire hazard. Lands may also have to be closed due to wind erosion caused by recreation use on drought-stricken lands. And, finally, the basic human consumptive needs in a recreation area may be precluded by the natural resource needs, causing certain areas to close for all or part of the recreation season.

The drought conditions facing our western states are extremely severe. The final decisions as to management of the problem reveal the importance of a thorough-going understanding of the overlapping implications of any action taken to preserve our natural resources.



Who Can You Turn To?

There are thousands of organizations on the state and local level interested in natural resource management. Many of these organizations provide technical assistance, for free or with compensation. In addition, state and local governmental bodies have departments with people intimately involved in various aspects of natural resource management. For information on a specialized area, check with your state agricultural extension service, the natural resources council, your state bureau of wildlife and fisheries (or fish and game), the state environmental protection agency, and area agricultural and forest experiment stations.

The following list of organizations and agencies provides information, and sometimes technical assistance, on particular natural resource management problems:

FEDERAL AGENCIES

Agricultural Research Service
U.S. Department of Agriculture
Washington, D.C. 20250

Agricultural Stabilization and Conservation Service
Washington, D.C. 20250

Animal and Plant Health Inspection Service
Washington, D.C. 20250

Cooperative State Research Service
Washington, D.C. 20250

Extension Service
Washington, D.C. 20250

Forest Service
Washington, D.C. 20250

Soil Conservation Service
Washington, D.C. 20250

National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Washington, D.C. 20230

Office of Coastal Zone Management
3300 Whitehaven St., N.W.
Washington, D.C. 20235

Office of Sea Grant
3300 Whitehaven St., N.W.
Washington, D.C. 20235

National Marine Fisheries Service
U.S. Department of Commerce
Nat'l Oceanic and Atmospheric Administration
Washington, D.C. 20235

Army Corps of Engineers
Office of the Chief of Engineers
Forrestal Building
Washington, D.C. 20314

Bureau of Indian Affairs
Dept. of the Interior
1951 Constitution Ave., N.W.
Washington, D.C. 20245

Bureau of Land Management
Washington, D.C. 20240

Bureau of Mines
Washington, D.C. 20241

Office of Water Research and Technology
Washington, D.C. 20240

Bureau of Outdoor Recreation
Washington, D.C. 20240

U.S. Fish and Wildlife Service
Washington, D.C. 20240

U.S. Geological Survey
National Center
Reston, Virginia 22092

National Park Service
Washington, D.C. 20240

Bureau of Oceans and International Environmental and Scientific Affairs
Department of State
Washington, D.C. 20420

Energy Research and Development Administration
Washington, D.C. 20545

Environmental Protection Agency
401 M St. S.W.
Washington, D.C. 20460

Federal Energy Administration
Federal Building
12th and Pennsylvania, N.W.
Washington, D.C. 20461

Federal Power Commission
825 N. Capitol St., N.W.
Washington, D.C. 20426

Federal Working Group on Pest Management
Rm. E431
401 M St., S.W.
Washington, D.C. 20460

Chesapeake Bay Center for Environmental Studies
RR 4 Box 662
Edgewater, Maryland 21037

U.S. Water Resources Council
Suite 800
2120 L. St., N.W.
Washington, D.C. 20037

NATIONAL PRIVATE ORGANIZATIONS

American Association for Conservation Information
publishes: The Balance Wheel
contact: George Feltner, Editor
458 Lowell Blvd.
Denver, Colorado 80204

American Association of Zoological Parks and Aquariums
Oglebay Park
Wheeling, West Virginia 26003

American Committee for International Conservation, Inc.
c/o John Perry
National Zoological Park
Washington, D.C. 20009

American Conservation Association, Inc.
30 Rockefeller Plaza
Room 5425
New York, New York 10020

American Fisheries Society
5410 Grosvenor Lane
Bethesda, Maryland 20014

American Forest Institute
1619 Massachusetts Ave., N.W.
Washington, D.C. 20036

American Forestry Association
1319 18th St., N.W.
Washington, D.C. 20036

American Geographical Society
Broadway at 156th St.
New York, New York 10032

American Humane Association
Box 1266
Denver, Colorado 80201

American Petroleum Institute
2101 L St., N.W.
Washington, D.C. 20037

American Rivers Conservation Council
317 Pennsylvania Ave., S.E.
Washington, D.C. 20003

Center for Environmental Education, Inc.
2100 M St., N.W.
Washington, D.C. 20037

Center for Natural Areas
(Affiliated with the Smithsonian Institution)
1525 New Hampshire Ave., N.W.
Washington, D.C. 20036

Citizens Committee on Natural Resources
1000 Vermont Ave., N.W.
Washington, D.C. 20005

Concern, Inc.
2233 Wisconsin Ave., N.W.
Washington, D.C. 20007

Conservation Education Association
publication: Newsletter
contact: Claude Crowley, Editor
Soil Conservation Service
Box 6567
Fort Worth, Texas 76115

Conservation Services, Inc.
S. Great Road
Lincoln, Massachusetts 01773

Defenders of Wildlife
1244 19th St., N.W.
Washington, D.C. 20036

Environmental Action Foundation, Inc.
724 DuPont Circle Bldg.
Washington, D.C. 20036

Environmental Action, Inc.
Rm. 731
1346 Connecticut Ave., N.W.
Washington, D.C. 20036

Environmental Policy Center
317 Pennsylvania Ave., S.E.
Washington, D.C. 20003

Environmental Research Institute
Box 156
Moose, Wyoming 83012

ESP: Endangered Species Productions, Inc.
175 W. Main St.
Ayer, Massachusetts 01432

Fish and Wildlife Reference Service
(under contract with the U.S. Fish and Wildlife Service to provide access to studies and reports)
Denver Public Library Service Bldg.
2100 W. Mississippi Ave.
Denver, Colorado 80223

Friends of the Earth
529 Commercial St.
San Francisco, California 94111

Izaak Walton League of America, Inc.
1800 North Kent St.
Suite 806
Arlington, Virginia 22209

John Muir Institute for Environmental Studies, Inc.
743 Wilson St.
Napa, California 94558

Keep America Beautiful, Inc.
99 Park Avenue
New York, New York 10016

National Audubon Society
950 Third Ave.
New York, New York 10022

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036

Natural Resources Council of America
Suite 914
1025 Connecticut Ave., N.W.
Washington, D.C. 20036

The Nature Conservancy
Suite 800
1800 N. Kent St.
Arlington, Virginia 22209

Renewable Natural Resources Foundation
5400 Grosvenor Lane
Bethesda, Maryland 20014

Resources for the Future
1755 Massachusetts Ave., N.W.
Washington, D.C. 20036

Sierra Club
530 Bush St.
San Francisco, California 94108

Society of American Foresters
5400 Grosvenor Lane
Washington, D.C. 20014

Wildlife Management Institute
1000 Vermont Ave., N.W.
709 Wire Bldg.
Washington, D.C. 20005

Wildlife Society
Suite 611
7101 Wisconsin Ave., N.W.
Washington, D.C. 20014

World Wildlife Fund
1319 18th St., N.W.
Washington, D.C. 20036