Trends

Incorporating
Guideline

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Introduction

The articles in this issue, while diverse, center around preservation—of architecture, of our history, of coastal areas and even of colonially nesting waterbirds. The everyday operation of a park or recreation area leaves little time to catch up on scientific research. The articles in this issue of *Trends* provide new insights into management of natural areas and some of the problems to avoid.

The central question which runs through each piece, including the article on the Rustic Style of architecture is: What price must we pay for change? We learn in the article on the Congaree Swamp that a tract of river bottom land which has somehow survived massive man-inflicted change may be lost to us forever. So often we hear only one side of an issue. In this article, the author, while clearly a proponent of preservation, offers a more objective view of some of the problems which confront us as we consider setting aside a valuable land area for future generations.

Several of the scientist-authors included in this issue share with us their concerns, their insights regarding the complexity of our shoreline, coastal regions and river areas.

In the report on Managing Marine and Lake Systems by Dr. Robert Dolan and his associates, and in the article by his colleague, Dr. Paul Godfrey on Shoreline Retreat, we learn about the difficult issues raised in managing coastal areas—how much change can one risk and what are the implications of that change? We are constantly told how sensitive nature is to change, but both authors show us nature's adaptability as well.

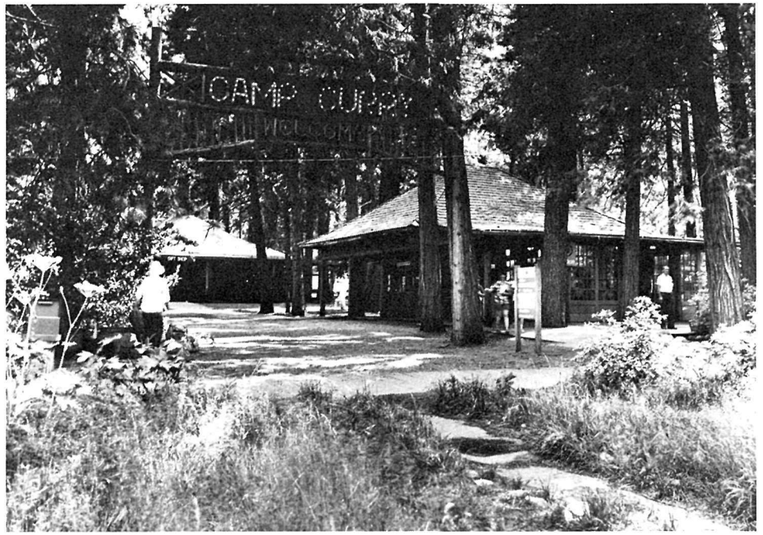
The guidelines for the protection of colonially nesting waterbirds provide practical suggestions for managing areas where many endangered colonies breed. At the same time, the authors offer us information on the nesting patterns of birds we commonly see in shore areas. The numbers of birds affected by man's intrusion in their nesting areas is vast—the problem has dramatic implications not only for the preservation of many species but also for the environment.

For those of us who live inland—Dr. Theodore Sudia offers us a look at the importance of the river in the city—its place in the ecological systems found in urban areas, its place in history and in town planning.

Regardless of one's location, the insights provided in the articles in this issue give us a better understanding of the key elements of our environment which affect us all.

Rustic Architecture: The National Park Style

by Merrill Ann Wilson



The Rustic style of architecture, prevalent in this country from around the turn of the century to 1940, is what might well be called the National Park Style. It paralleled the establishment of our great western national parks and is a reflection of the period's interest in conservation of natural resources.

This little noticed movement in American architecture was a natural outgrowth of a new romanticism about nature, about our country's western frontiers. It evolved at a time when writers like Ralph Waldo Emerson, Henry David Thoreau and James Fenimore Cooper were busy painting portraits in words of man in nature while landscape artists shifted from lovely pastoral scenes to images of untamed natural splendor.. Artists like Thomas Cole, George Catlin, Frederick Church, Albert Bierstadt and Thomas Moran exalted in the shear spectacle of mountain scenes with rough running streams.

Special expedition parties, often complete with photographers and landscape painters, explored areas such as Yellowstone, Yosemite and the Rocky Mountains. The paintings and photographs of these expeditions had tremendous impact on the public and did a great deal to promulgate the concept of national "preserves" or parks.

The conservation ethic slowly took hold in this atmosphere of romanticism. Part of this ethic fostered the development of a unique architectural style. Perhaps for the first time in the history of American architecture, a building became an accessory to nature. It was believed that nature could not be improved upon and that harmony with nature was the goal of architectural design.

Early pioneer and regional building techniques were revived because it was thought that a structure employing native materials in a natural or rough condition blended best with the environment.

Architectural expositions around the turn of the century saw the first examples of the Rustic style.

The Adirondack camps of the late 19th century are clearly precursors of the style, but were limited in influence since they tended to be a localized development which can still be seen in that region. The camps, stylistically, bore a strong resemblance to the Victorian era's "Stick style," with their ornamentation expressed in sticks and bark instead of machine-sawn timbers.

Up to that point, American architecture relied on European precedents, the Rustic style did not. It was the National Park Service, from 1918 to the 1940's, that was responsible for nurturing and promoting the Rustic style (a term in fact coined by a Park Service publication—see below). No single governmental agency has to date been responsible for such a revolutionary break in architectural form.

Stephen Mather, the first director of the National Park Service, envisioned the parks as "reserved places of great natural beauty" which were important in everybody's daily life as those utilized areas that took care of physical needs,' because "natural scenery. . .makes better men and women physically, mentally and spiritually." (*American Civic Annual*, I, 1929)

With this concept of public use and enjoyment of the parks, it was necessary to provide for visitor and administrative facilities in the parks. Above all, the intent was to make the structures as unobtrusive as possible to in no way diminish the natural values for which the park was established.

The National Park Service set out to formulate a design criteria for an architectural style of restraint and sublimation to the environment:

"Since the primary purpose of setting aside those (natural) areas is to conserve them as nearly as possible in their natural state, every structure, however necessary, can only be regarded as an intruder."

This statement found in the introduction to the book which firmly established and named the Rustic style, *Park Structures and Facilities*, published by the Park Service in 1935, sets the tone for the style.

The book was more than a statement of national policy regarding architecture in the parks. It was a set of guidelines for all the Public Works Administration, Civilian Conservation Corps and other federal building projects in natural settings. By 1938, the revised version of the text included many examples of structures built by these public works projects as exemplary of the Rustic style.

The preface to the book suggests that general guidelines for design: "to achieve a sense of unity, all structures in a park should be designed in one style, with limited construction methods and a limited variety of materials." The book notes that scale is a critical element of the rustic style. Structural members should be scaled to the surroundings. If the park is forested with huge trees, the size of the logs used in a structure must be scaled accordingly. Generally, the more rugged landscapes required the most oversized materials (logs two feet in diameter, and boulders for masonry) and the less rugged landscapes required proportionately smaller materials.

The building, stylistically, was to reflect the area's building traditions and other characteristics of the region.

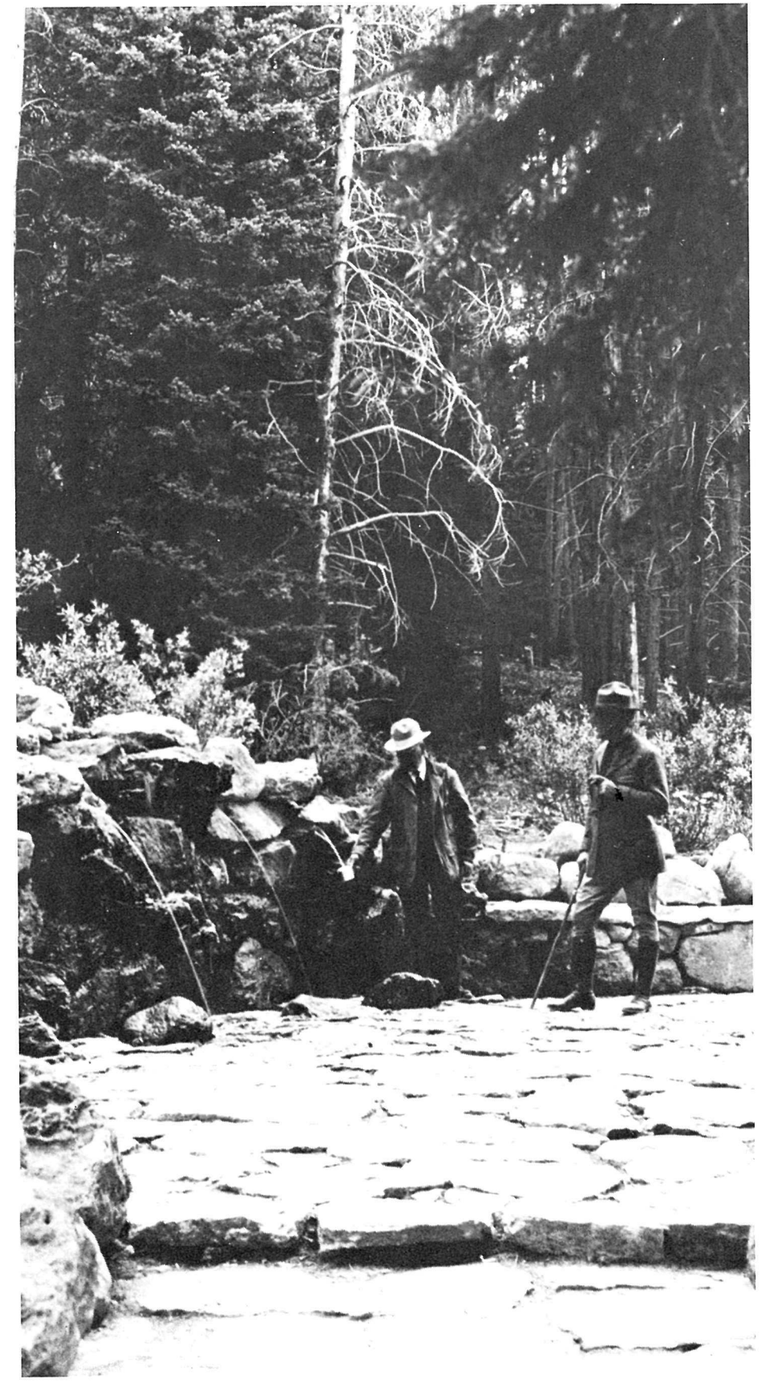
Horizontal lines and silhouettes were preferable to verticality. The structures were to avoid rigid, straight lines and convey an impression of having been executed by pioneer craftsmen with limited hand tools, even if the most modern methods and materials were in fact employed. For example, a rough rock foundation wall could be backed with reinforced concrete.

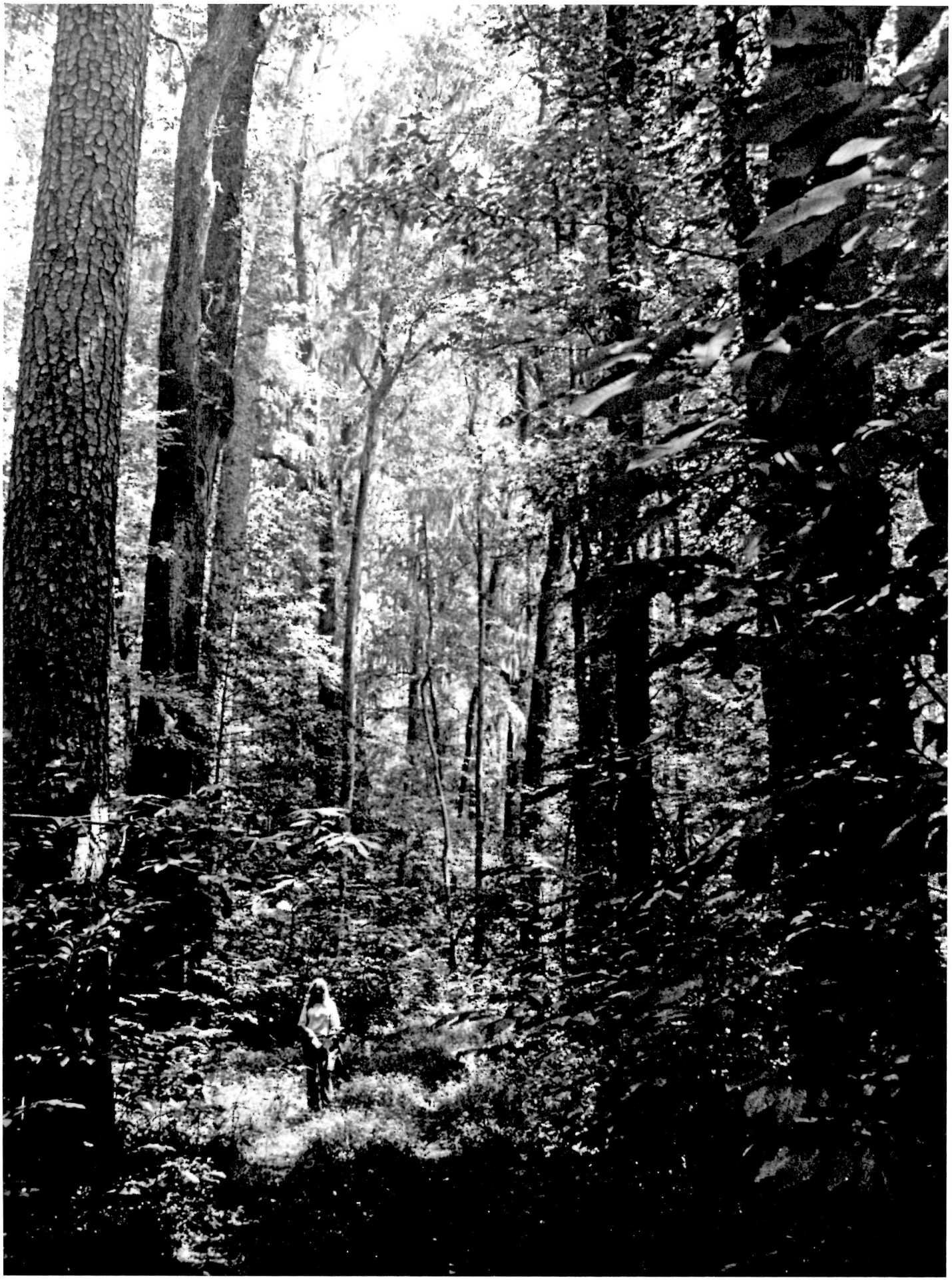
In sum, native materials in their natural state were preferred. Masonry was meant to give the impression of natural rock outcroppings by varying the size and placement of stones. Logs had to be selected for their roughness. Peeling was recommended for their longevity. Roofing should consist of thick wood shingles and painting and staining of rough-sawn timbers and shingles was recommended in warm browns and driftwood greys.

Landscaping was also an important part of the Rustic style. Careful screening with native trees and plant material helped to make the structure blend into its environment.

In sum, these impressive structures represent an important architectural contribution to this country. It established a style in harmony with nature which today is in stark contrast to many structures which make little attempt to relate in materials or design to the surrounding area. The rustic timber and stone buildings found in our national parks from that era represent an important irreplaceable architectural resource which should be used and conserved.

Ms. Wilson is an historical architect at the National Park Service' Denver Service Center.





Preserving the Congaree Swamp

by Robert L. Janiskee

Preservation of the Congaree Swamp has for the past 6 years been a hotly contested issue both in the swamp's native South Carolina and in the halls of Congress.

What is it about a swamp that has attracted so much attention, so much debate? In a nutshell, the Congaree Swamp offers us an opportunity to preserve a collection of record trees, vegetation and wildlife which has all but vanished in the past century. The Congaree Swamp is in fact a river bottom hardwood forest typical of the South until the rapidly growing lumber industry descended in the 1880's.

It is the clear-cutting of those very hardwoods which distinguish the Congaree Swamp which now threatens to extinguish it as a national preserve.

It is about 70,000 acres in size occupying virtually the entire flood plain of the river (which extends a meandering 55 miles from just below Columbia until it merges with the Wateree and Santee swamps near the river's mouth).

The most spectacular and valuable area of the swamp is the "Beidler tract" (named for the family which has owned it for three generations), an area of approximately 14,700 acres located on the northern side of the river beginning about 15 miles below Columbia and extending along the northern side for about 11 miles in a strip averaging 2–2½ miles in width.

While the Beidler tract and the Congaree Swamp remain in private hands, lands near it have been preserved by public ownership. The Four Holes Swamp Sanctuary (Frances Beidler Forest) an Audubon property has been preserved as the Santee Swamp, a 6,231 acre state-owned wetland.

When is a Swamp a River Bottom?

The periodic flooding and the presence of sloughs (or "guts") and bogs qualifies the Congaree as a swamp in the ecological sense of the term. In the more conventional use of the term, it is a river bottom hardwood forest community.

Most of the Congaree Swamp is reasonably dry except after floods or unusually heavy local rains. The forest floor is clear of heavy undergrowth in most places and might be described as grove-like except for vines, shrubs, and occasional cane breaks along the creeks and river banks. It is sometimes described as having a tropical rainforest appearance, especially when viewed from above.

The lower level of the swamp, which is inundated during much of the year, harbors bald cypress, water tupelo, button bush, and other species of trees and shrubs that can grow in standing water the year round. The upper level of the swamp, flooded only during short periods, generally stands about 1 to 4 feet above the level of the sloughs and ponds. The plant community of this level consists of about 100 species such as sweetgum (the most common tree in the swamp), oak, hickory, and ash.

Though none of the trees in the upper level can grow in water which stands the year round, all can tolerate standing water for a few days or a few weeks at the time. Characteristic plant associations are found elsewhere in the swamp, such as along the northern bluffs, in the vicinity of bogs and ponds near the northern edge, along the river banks, and along nearby field edges. Several other species, especially dogwood and tulip poplar, are found only on the few low dirt mounds which were built long ago to shelter livestock from floods. Some stands of shade-intolerant loblolly pines, normally a rarity in a bottomland hardwood forest, are found along the northern edge of the swamp, and in some places deep within it. The best explanation for their presence seems to be the occasional occurrence of forest fires, or violent storms which open substantial gaps in the forest canopy. A number of shade tolerant shrubs are common in the understory.

The swamp supports wildlife typical of southern bottomland hardwood forest habitat. The bird life has been studied to a much greater degree than the other fauna, and it is known that rare and endangered species such as the red-cockaded woodpecker, Mississippi kite, swallow-tailed kite, Swainson's warbler, osprey, and bald eagle share the swamp with more common birds such as owls, ducks, and wild turkeys. Deer, raccoons, wild hogs, and squirrels are among the more common mammals.

It is not the wildlife that makes the Congaree Swamp so special a place. Rather, it is the relatively unspoiled appearance of literally thousands of acres of the forest, and most particularly, the unusually large size of the trees. The most spectacular stands are found in the "Beidler tract."

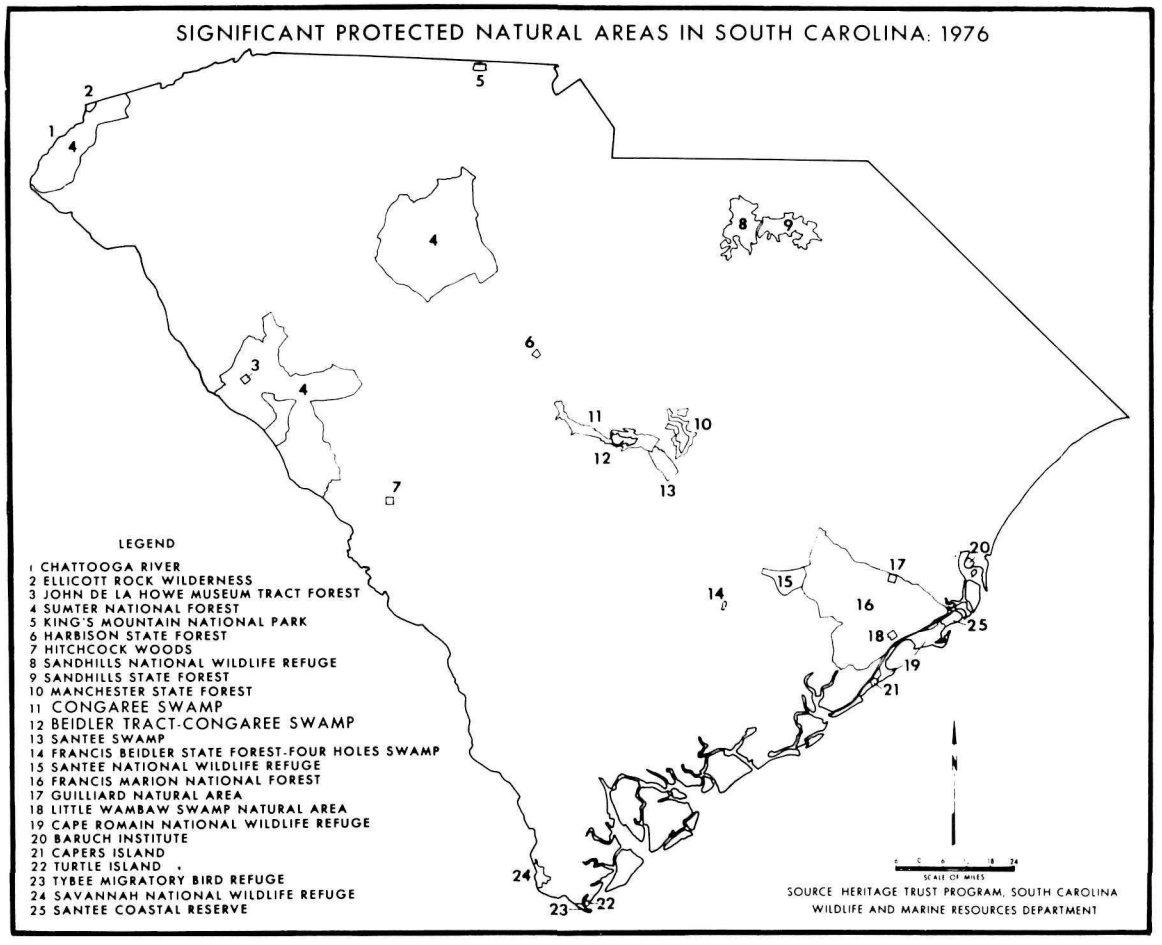
The flood waters which inundate portions of the tract (about 10 percent of the

time in an average year) provide moisture and nutrients which promote the growth of trees in this climax forest which can only be described in superlatives. It is a "forest of champions" in the literal sense of the term, for some of the trees are of record size and for each of these there are others of similar proportions. A recent compilation established that seventeen state record trees, including five national champions (loblolly pine, overcup, oak, possumhaw, laurel oak, and swamp tupelo) are found in the Beidler tract; additional record-size tree are reported to exist on in-holdings. Still larger trees may yet be discovered, for much of the area has not been carefully explored or timber cruised. The trees often grow to unusual heights for their species, commonly in the 130 to 150-foot range for the taller ones, some of which top 160 feet. Many of the giants are unusually old for their species. For example, although loblolly pines seldom grow older than 200 years elsewhere, there is a stand of these pines (including the national champion) in the Beidler tract which is more than 300 years old! Cypress trees 500 to 700 years old are fairly common, and a cypress log with 1600 rings was hauled out of the general area around the turn of the century.

Yet, despite its atmosphere of remoteness, the Beidler tract ranks as one of the most conveniently located significant wilderness areas to be found anywhere in the eastern U.S. It lies within the primary recreational demand area of the Columbia Standard Metropolitan Statistical Area (SMSA), with its 322,000 plus population. Regionally, more than 14 million people live within 300 miles of the Beidler tract, a distance which can be described as a relatively easy day's drive on routes feeding into an excellent interstate highway network focussing on Columbia.

Valuable from All Points of View

The very characteristic which makes the tract so appealing to preservationists is the reason for the controversy over the land. It is a commercially valuable plot. The Beidler heirs are interested in selling their land for an as yet undetermined fair market value (which has been "guestimated" at around $31 million), the Beidler tract is presently being delivered piece by piece to the plywood and furniture factories in South Carolina. Both selective logging and clear cutting practices have been proceeding at the rate of about 500 acres per year. Approximately one-fourth of the tract (about 3,500 acres) has been cut since 1969. Logging has moved into some of the best portions of the tract, seriously disturbing or eliminating two of the eleven plant community types representing distinct associations of species, and threatening the rest. The preserve concept is based upon the uninterrupted presence of representative stands with large canopy trees. Thus, the reduction of community diversity resulting from logging is viewed with growing alarm. It is difficult to specify precisely how much additional



logging can be tolerated before this desirable attribute of the preserve is irretrievably lost.

If the Beidler tract's future is uncertain, one fact remains abundantly clear as long as the tract remains privately owned, there can be no guarantee that its present ecological integrity and unique biological attributes will not be destroyed forever. Once the virgin tract is systematically logged, it cannot be restored to a pristine condition at any cost. The present pace of logging, even if it is not stepped up, will insure that the Beidler tract will be reduced to a pitiful shadow of itself within relatively few years.

A Fine Old Heirloom

A central facet of the preservationist argument is that the climax forest of the Beidler tract is part of the nation's declining natural heritage of special places which should be saved for future generations to enjoy. River bottom hardwood forests like this were typical communities in the South when the rapidly growing lumber industry descended on the grand southern swamps in the 1880s. By World War I, only scattered pockets of virgin timber were left, and since that time urbanization, drainage control, reservoir construction, agricultural clearing, and the like have joined with logging to take a heavy toll of even this scattered remnant. But the Congaree's Beidler tract survived essentially intact.

The Beidler company logged more readily accessible cypress along the waterways around the turn of the century by a long and tedious process under malarial conditions which took a heavy toll of the logging and milling crews. Further harvesting was deemed marginally profitable at best, and by 1914 their sawmill was permanently shut down. The Beidler heirs subsequently held the land, and offset tax payments by leasing hunting rights, harvesting other timber holdings and waiting for the opportunity to begin logging their Congaree tract. During this interval, the Beidlers were forced in the 1930's to sell—at what they considered to be an unfair price—about 60,000 acres of bottomland forest (about half of their South Carolina holdings at that time) so that Lake Marion could be impounded incident to the construction of the famous Santee-Cooper complex.

Logging operations were recommenced in 1969, but by then it was obvious that the Beidler tract was no longer just another bottomland hardwood forest. In terms of its area extent and biological characteristics, it was now a modern day dinosaur and quite literally beyond comparison.

The claims that the climax forest of the Beidler tract is not a bona-fide primitive area are fundamentally weak, bearing witness only to the fact that it is difficult to find any area of some square miles in extent on the Eastern Seaboard which hasn't been altered to some visible extent by modern man. At that, the existing signs of man's encroachment in the tract are of the fleeting and ephemeral variety. It is worth mentioning that a decidedly rural atmosphere prevails in the vicinity of the Congaree Swamp. This fringe area is by-and-large a zone of small farms, a few stores and gas stations, some churches and school houses, and large, heavily cut tracts of pines.

Those who would suggest that the record trees and a few of their neighbors represent the essence of that which should be preserved are confusing the issue; the question here is whether we should preserve a record *forest*, not whether we should save some trees that might be called interesting specimens. Those who argue that selective logging and occasional clear cutting would not disrupt the functional ecological integrity of the climax forest refuse to acknowledge that timber harvesting artificially imposes simplicity on a complex habitat. No one has yet offered an adequate explanation of why the Beidler tract, a quietly isolated area remarkably free of man's artifacts, would not be fundamentally changed by the bustle of logging activity and by the stumps, splintered trunks, slash, sawdust, gashes, and trails left in its wake. Meant to be passed from generation to generation are fine old heirlooms, not the shoddy common currency or settings with the stones removed.

The arguments relating to the preservation of the swamp's fundamental ecological integrity require a great deal of public education, a difficult task in view of the stereotypical swamp—sapping miasma, voracious mosquitoes, snakes and formless terrors lurking in the gloom.

The more saleable argument then is that the land can be used for recreational, educational, scientific and other needs in "multiple-use" fashion.

Sustained-yield hardwood forests obviously provide continuing sources of employment in the wood products industry. To county governments, these income-producing operations mean tax revenues. To outdoorsmen, they are places to hunt and to fish. To these people and to many others, multiple-use timber harvesting operations have come to be associated with economically and socially valuable concepts such as wealth, productivity, and opportunity. Forest preservation, on the other hand, has come to be associated with negative concepts such as "idle" land, inefficiency, and self-denial.

Critic's View

Critics of the preserve proposal have made much of the fact that most of the Congaree Swamp has been repeatedly logged for many years. In the Old Kingsville Station area, for example, the Holly Hill Lumber Company has harvested a 12,000 acre "tree farm" tract for more than 30 years. Even the Beidler tract itself is not a truly primitive area in the strictest construction of the term. It was selectively logged for cypress along the creeks and guts by the Beidler's Santee River Cypress Lumber Company around the turn of the century. No roads were built, no hardwoods were cut, and most of the swamp was left undisturbed; the objectionable scars have greatly diminished. The Cedar Creek Hunt Club has constructed several clubhouses, several miles of improved dirt roads, and about 25 miles of jeep trails. There are a few remnant field dikes (c. 1830–1842), some small cleared fields, and a few cattle sheds along the river. Cattle and hogs are still grazed in parts of the swamp as they have been since Colonial times. In sum, portions of this swamp have been used by man for one purpose or another for the last 235 years.

There have been promises that record-size trees will not be cut, and that buffer strips will be left around them. Though some clear cutting would be employed to promote regeneration, the basic method of harvesting would involve the selective cutting of trees which are, in the parlance of the professional forester, "overmature." The Beidler's consulting forester has told them that their timber values will deteriorate if the trees are not harvested soon, adding that nature will surely harvest trees that man does not. This line of reasoning tends to be well received by a public which has been carefully schooled

in the fact that sound conservation demands the utilization and replacement of renewable resources with a minimum of waste. An extension of that reasoning is that logging the Beidler tract would be conservation at its ideological best, and that sparing a few of the forest giants or a few thousand acres of the forest itself would be an expansively benevolent gesture.

A phenomenon worthy of special mention is the raising of hackles resulting from any implication that the acquisition of a forest preserve might have to be accomplished by condemnation proceedings under the government's rights of eminent domain. Posed as a serious issue, the "invasion" of traditional personal property rights (regardless of whether it is real or imagined) offers a rallying point for anti-preservationist sentiment and tends to muster the support of many who would otherwise be apathetic witnesses to the conflict.

Critics of the preserve proposal have also largely stressed the economic impact, including so-called "multiplier effects," on the very important South Carolina forestry industry. This impact is expressed in terms that the public can easily relate to—the loss of productivity, and especially the loss of jobs. The potential loss of tax revenues has been cited quite pointedly by opponents of the preserve. However, research has shown that the creation of the preserve will remove only about 0.5 percent of the state's hardwood forest from commercial production. South Carolina has more than 5 million acres of other hardwoods in addition to about 6 million acres of softwoods, and more than 60 percent of the state's land area is already in commercial forest. It can therefore hardly be said that the economic health of the state's forest products industry hinges on the productivity of the Beidler tract.

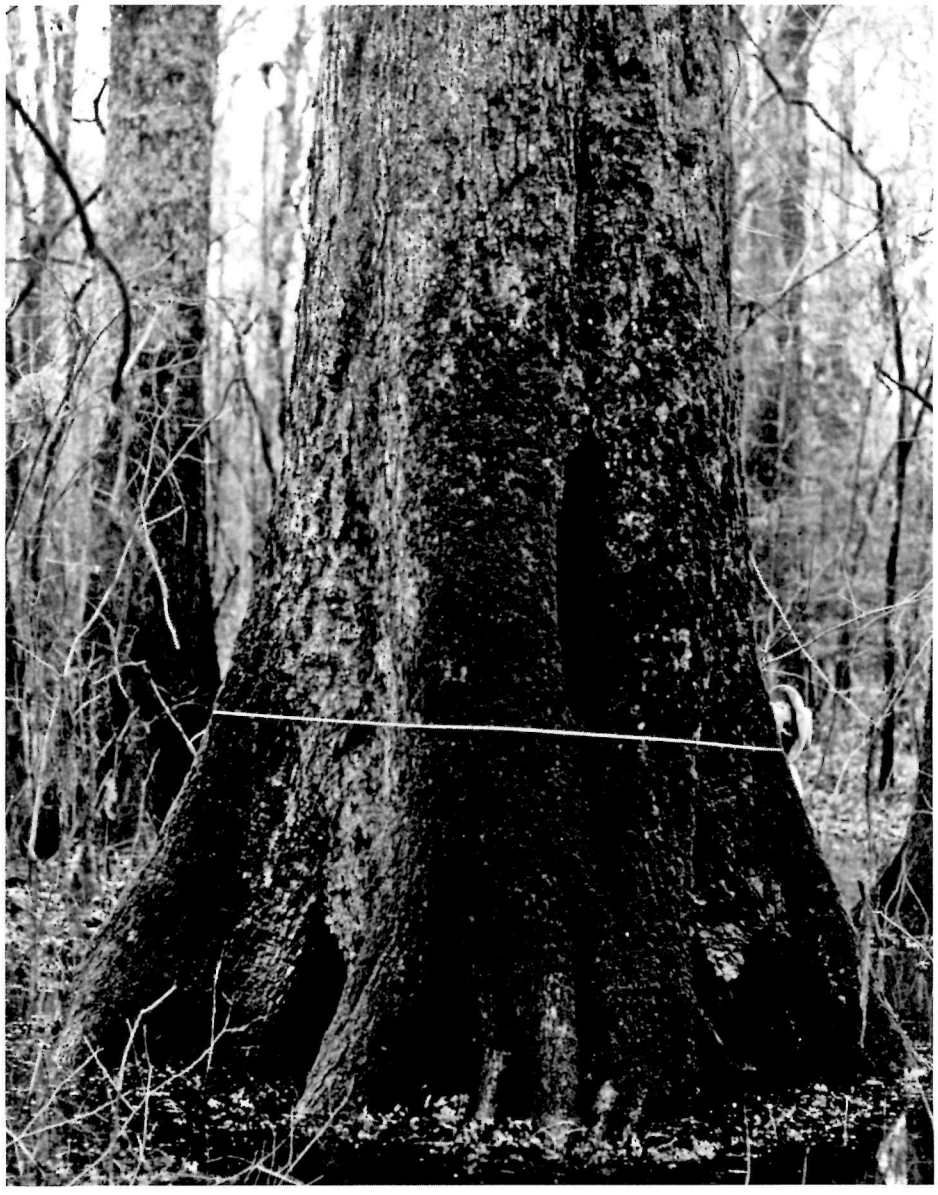
At the local level, Beidler tract hardwoods constitute about 2.8 percent of the sawtimber acreage and about 6 percent of the sawtimber volume in the nine-county Congaree Swamp Timber Market Area. In recent years it has accounted for about 1.8 percent of the market area's hardwood sawtimber production, mostly in the form of highly desirable large diameter veneer logs. Alternative sources of hardwood sawtimber are readily available within the market area, and so substantial decline in production need not necessarily occur through the loss of the Beidler tract's contribution. Shortages of large diameter veneer logs could conceivably occur until veneer log production is increased elsewhere in the market area. In consequence, buyers would have to pay higher prices to induce production, transport logs greater distances, and possibly even curtail usage until hardwood forest owners responded to the incentives to produce more trees of large size.

During the period 1970–1973, an estimated 1.3 percent of the employment and payroll in the market area's timber-using industries was associated with the Beidler tract's harvest, roughly the equivalent of 91 jobs and an annual payroll of $623,000. To date it has not been demonstrated that any of the 3,566 people employed in the market area's lumber and wood products industry would necessarily suffer job losses directly attributable to the creation of the preserve. However, if veneer log usage were curtailed, a temporary adverse impact on employment in the market area would be a likely result.

Advocating Protection

Proponents of the preserve are confident that informed public opinion will favor the creation of a Congaree Swamp National Preserve.

The central question is not whether the preserve will look like a good idea when we are all dead and gone; rather, it is whether and to what degree it will provide



tangible benefits while we are alive. One central argument against the preserve proposal has been that the spending of millions of dollars of tax revenues will effectively relegate thousands of acres of land to an "unproductive" status.

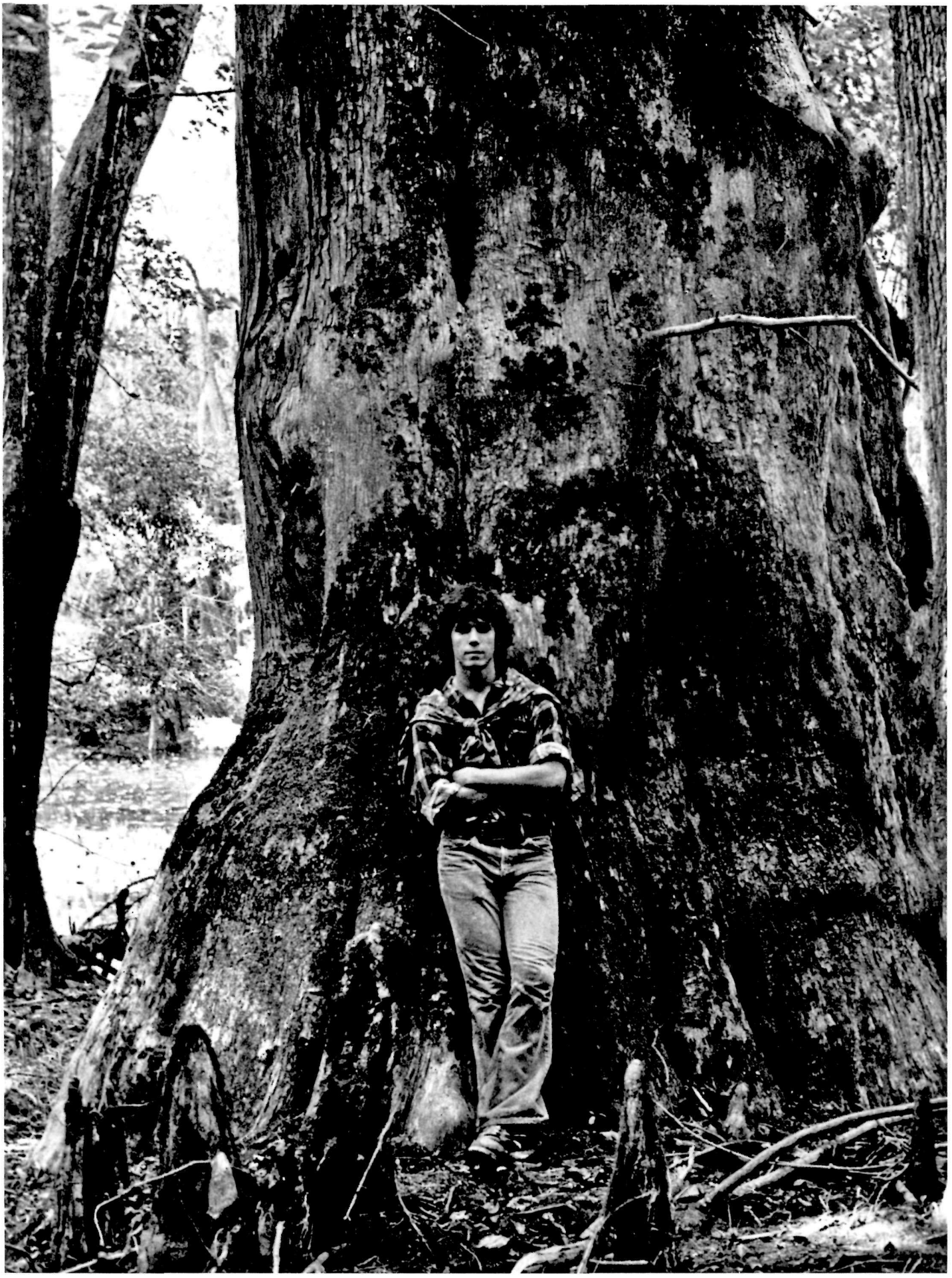
This argument is based on the assumption that the Beidler tract is not desirable for general public use. However, the National Park Service, the South Carolina Wildlife and Marine Resources Department, and others who have studied the tract have suggested that a preserve would offer significant opportunities for public uses that would be compatible with the protection of its essential qualities.

The problems associated with high temperatures, mosquitoes, high water, and other access-limiting factors tend to be seasonal or periodical in nature, being largely confined to the hottest and wettest months of the year. During the cooler and drier 6 or 7 months of the year, the tract can provide significant outdoor recreational, educational, and other benefits. With proper management, it appears that it can be a popular facility for sightseers, hikers, campers, canoeists, boaters, picnickers, photographers, nature study enthusiasts, or anyone seeking solitude to escape from urban noise and other "city troubles."

The Park Service study published in 1963 recommending that the tract be established as a Congaree Swamp National Monument briefly outlined a development plan which would provide land and water visitor-use routes and facilities as well as ancillary improvements such as service roads, administrative headquarters, personnel housing, and the like. With the active support of groups such as the Sierra Club, the South Carolina Environmental Coalition, and the Audubon Society, the Congaree Swamp National Preserve Association has worked toward the goal of establishing a Congaree Swamp National Preserve as South Carolina's first natural area unit in the National Park System.

A day-long "Congaree Action Now!" rally was staged in the state capital on September 20, 1975, to shift the preservation movement into high gear. Even the sponsors were surprised when more than 700 people showed up to listen as scientists and nationally prominent environmentalists joined local leaders in documenting the case for preservation. Significant developments were to follow in rapid succession shortly thereafter. In November, the Beidler family announced their willingness to sell all or part of the tract at fair market value. In December, a South Carolina Wildlife and Marine Resources Department survey of the Beidler tract was released.

Its findings were consistent with the preservationists' argument, and it served



as a stimulus to action for those who had withheld judgment pending its release.

At present, the problems associated with acquisition *per se* can only be discussed in general terms. It is fair to say that the mood of fiscal austerity rooted in the recent economic recession has given many people cause for pause in their endorsement of the preserve concept. With acquisition costs measured in tens of millions of dollars, it is apparent that these funds must come from tax revenues. The state of South Carolina has no budget surplus, and has in fact recently experienced declining tax revenues. There is little to suggest that state tax revenues could be made available to purchase a preserve of adequate size. Federal acquisition is therefore deemed necessary, though some influential proponents of the preserve would prefer to see it remain under state control. The Beidlers have thus far remained unwilling to negotiate a trade of their Congaree Swamp holdings for forested land of comparable value already in the public domain. Consequently, an outright federal purchase appears at present to be the only feasible means of acquisition.

Status of the Proposed Preserve

In February, 1976, Governor Edwards of South Carolina discussed preservation options with the U.S. Department of the Interior officials, signaling a major shift in his position on the issue. That same month, the South Carolina General Assembly passed a resolution urging the establishment of a preserve in the Congaree Swamp, and a bill (H.R. 11891; identical to H.R. 12111) asking congressional authorization for federal acquisition of the Beidler tract was introduced in the U.S. House of Representatives. The Park Service dispatched a study team to the Beidler tract in mid-March to update the report the agency published in 1963, and the House Subcommittee on National Parks and Recreation scheduled public hearings on the preserve bill in April. Similar bills were introduced into the Senate in the spring (S. 3498 and S. 3497). At this writing, it remains to be seen whether the bills will be voted out of committee and scheduled for a vote during the current session.

Proponents of the preserve have rather confidently assumed that a federal acquisition will be approved, that funds will be authorized for purchase, and that funds will then actually become available. However, a dispassionate view of this situation

suggests this may not be possible. The National Park Service has been caught increasingly in a financial squeeze as well as in policy disputes between the Administration and Congress.

Despite a Congressional push for more federal money to acquire park and recreational areas through the Land and Water Conservation Fund, the Office of Management and Budget wanted to eliminate the appropriation altogether in fiscal 1977. OMB was overruled, and the Administration budget contained a request for $300 million to be appropriated from the Fund.

Even if this amount is incremented somewhat by additional appropriations, it will still fall woefully short of needs. According to the Bureau of Outdoor Recreation, the Park Service acquisition backlog just for areas *already* authorized for purchase is some $533 million. Of the $300 million in appropriations requested for 1977, more than half is earmarked to provide matching grants to states for acquisition, and only $77.3 million is designated for the Park Service. Significantly, the lion's share of this is earmarked for land purchases in only three areas; Big Cypress National Preserve in Florida, Big Thicket National Preserve in Texas, and Cuyahoga Valley National Recreational Area in Ohio.

There is a congressional mandate that the Park Service finish acquiring these three large new areas within six years. It appears that Big Thicket alone will have an acquisition backlog totaling more than $50 million after fiscal 1977. This, plus the fact that the Park System is short on funds and manpower for operations and maintenance, is bad news for areas already authorized for purchase. It is even grimmer news for areas such as the proposed Congaree Swamp National Preserve whose purchase has not as yet been authorized.

Unfortunately, even if the acquisition backlog were eliminated and the operations and maintenance budget increased, it remains that the Congaree Swamp National Preserve is not the only proposed new unit of the National Park System. In April, 1975, no fewer than 60 such areas (not including historical areas) could be identified, and the roster of proposed national parks, recreation areas, seashores, lakeshores, monuments, historic sites, historical areas, historical parks, military parks, battlefield sites, scenic riverways, and wild and scenic rivers has since been expanded.

If and when acquisition of the preserve is approved, the scramble for funds promises to be frantic and a protracted delay in actual acquisition seems scarcely avoidable. Barring a moratorium on logging in the Beidler tract, the climax forest of the Congaree Swamp—a unique, magnificent, irreplaceable natural landscape relic—will suffer the ignoble fate of the death by a thousand cuts.

Managing Coastal and Lake Systems

by Robert Dolan, Bruce Hayden, John Fisher and Paul Godfrey

In their natural state, marine and lake systems accommodate a wide range of wave and storm surge conditions. A proper management strategy must include protection of this natural state, even within areas designated for recreation pursuits. Seashore and lakeshore areas have high potential for recreational use, and if concern for the natural state is part of the management strategy, confrontation with nature should be avoided.

Essentially, any management strategy for these areas must address three basic questions:

1. What is the nature of the shoreline?
2. How does it behave?
3. Where are the areas of maximum physical and biological variability?

The health of any shoreline environment depends upon its "freedom" to balance the powerful forces of storm waves and winds with various changes in its physical state. Management must recognize this dynamic nature. The results of man's past efforts to stabilize the primary interfaces of beaches and coasts have been largely negative, often resulting in more serious management problems than existed with the natural state.

There is constant motion between land and sea on any coastline. On sand beaches, each wave alters the interface as materials are transported offshore, onshore, and in the direction of the prevailing longshore currents. In this way, beaches constantly adjust to accommodate different wave and tide conditions. When the waves are high, the active zone of the beach expands both landward and seaward. Conversely, the active beach contracts when waves are low. During hurricanes and other severe storms, the beach must make major adjustment to dissipate the increased wave energy. If the waves and surge are very high, the runup may extend into zones normally associated with windblown deposits. This penetration of water and sediment is called overwash. This phenomenon occurs frequently in natural systems, creating wide irregular biophysical interfaces. Stabilized dunes lead to narrow linear interfaces along the dune crests.

Biologic boundaries between ecosystems are called ecotones. In a beach ecotone, relatively few inhabitants are visible without the aid of a microscope. Mole

crabs and coquina clams are among the few organisms that can withstand the high stress and constant motion of the beach sands. Feeders and nesters are temporary residents of the beach. Countless shore birds come to feed while several marine organisms nest on the beaches. Among the most important are the sea turtles and the grunion. Irregularity of the shoreline, coupled with tidal fluctuations, maximize the total length and width of this ecotone and hence its productivity.

The overwash ecotone, only sparsely vegetated with beach grasses, serves as the nesting grounds of numerous shore birds (see story on nesting waterbirds, this issue). It represents one of the few natural grasslands in the eastern United States. When protected from the periodic replenishment of beach sand and oceanic overwash, as in the case of the altered North Carolina barrier dune system, the ecological response is a progressive succession from grasses to shrub to forest. The irregular overwash pattern on a natural barrier island creates an ecotone perimeter length far in excess of its shoreline length. This same perimeter region in the altered system is usually a narrow strip along the backside of the barrier dune.

The behavior of physical interfaces and their associated ecotones is a manifestation of the interacting processes of the marine environment. These processes often have adverse effects on the shoreline systems from the standpoint of man's use.

We are aware of the continual rise in sea level which has resulted in shoreline recession throughout the world. In some areas, storm waves and surge accelerate erosion and deposition. Nevertheless, beneficial results can also be derived from these processes. The combination of a rise in sea level and storm surge transport material from construction of primary interfaces and nourishment of secondary interfaces. This balance is characteristic of the natural behavior of unmodified shoreline systems. Maintaining this balance is essential to the health and preservation of the marine parks, and it defines their optimum carrying capacity.

A good management strategy should be based on the character of the primary and secondary interfaces. Essentially, the environments can be divided into four distinct classes: mobile materials, resilient organics, immobile materials and human artifacts.

The primary interface for mobile materials is the beach where waves and surge constantly transform the shape of the easily-moved sand deposits. Self-generating coral reefs or mangrove forests provide the first line of resistance to the forces of the marine environment. They provide a resilient organic barrier.

Massive rocks and cliffs and other immobile materials are the third classification. These elements are slow to change and their secondary interfaces are complex. Finally, human artifacts—e.g., lighthouses, settlements, form the fourth environment which helps to determine the special features of the marine environment.

Waves and Beaches

It is the fluid and material motion within and across the beach which sustains the physical and ecological health of the barrier islands. The beach interface is the primary or controlling interface. The balance between sand transport and plant stabilization is heavily weighted towards the transport of sands. Periodic phases of erosion and deposition are superimposed on the longer term trend of a rising sea level, which submerges the beach and forces the barrier islands ever closer to the mainland.

Historically, man has taken numerous measures to stabilize the beach interface by constructing groins, sea walls and dunes. The focus of wave and surge energy is altered with each of these, providing protection for specific sites, usually at the expense of the land areas down the shoreline. With the prevailing trend of rising sea level and the occurrence of severe storms, these measures are only temporary.

The building of barrier dunes or hurricane dikes is of special significance. The

result is the division of the islands into two distinct subsystems. On the seaward side of the dune, wave energies are concentrated and erosion is accelerated. On the landward side, wave and surge energies are eliminated and the natural behavior of secondary interfaces is severely altered.

Winds and Dunes

Naturally formed dunes are generally low in form and are individual sand masses rather than long dune chains. The winds cause them to be frequently eroded, breached and rebuilt.

For many years, barrier dunes have been interpreted as natural barriers to overwash and erosion. Extensive programs of dune encouragement were initiated—sand fences built, sands trapped, and dunes formed and stabilized with grasses. In some areas, dune growth is naturally enhanced by rapid vegetative growth. Succession proceeds to forest communities and large-scale sand trapping. Stabilized dune systems naturally result and are essentially permanent features of the landscape.

If the natural process is allowed to take its course, however, dunes rise and fall with the winds and waves. Dunes tend to confine storm waves to the beach zone. Thus beach erosion is enhanced and plant succession behind the barrier dune is unchecked by overwash and salt spray. Dune vegetation traps wind-blown sands, dune height increases, erosion undercuts the dune faces, the dunes are destroyed and the system reverts to its natural state, only to possibly begin the process again.

Surge and Overwash Terraces

Major hurricanes and winter storms have such power that they may cross islands and transport sand inland in large quantities. Periodic overwashes of sand are essential to the maintenance of the barrier island form and structure. They create sand terraces and the character of these terraces is a function of their age and the ecological succession of their plant communities. Specifically, a recent terrace formation may well be characterized by open grassland. An older terrace by high salt marshes and shrub savanna. The oldest terraces are formed by low salt marshes.

The terracing causes dramatic ecological implications. In the instance of barrier islands, the frequency of overwashes precludes the succession to a forest community in all but the most protected sites. The grasslands of the natural barrier islands of the mid-Atlantic coast perpetuated by overwashes, are the only natural grasslands in the eastern United States, a unique natural phenomenon.

It is easy to understand how the alternation of barrier islands by man has a profound effect on ecological communities. By inhibiting overwashes, natural disturbances are eliminated and the succession process continues. Programs of controlled burning are needed to eliminate the resultant shrublands in favor of grasslands. In this case, fire is used in place of the natural overwash process; this practice must be added to the cost of dune-building programs.

Barrier islands represent a complex of physical and biological interfaces subject to rapid and continuous change. They are fragile areas which should have a minimum of visitor impact. Dune stabilization retards island growth. Within the context of a rising sea level, it minimizes island width. Stability of the barrier islands and sand beaches leads to less biologic productivity and diversity.

A management strategy based on the concept of encouraging stability has real costs in terms of biological resources and related recreation. There are no easy answers to the problem. After decades of experience and research on stabilized and unstabilized systems, no lasting solutions to protection are available. It is important to understand the implications of every man-directed action. Temporary measures, such as beach nourishment, barrier dune enhancement, sea walls, and groins, must be selected with great care.

Coasts of Resilient Organics

Living interfaces—where the balance between the life and death of the primary

controlling interfaces requires new approaches to recreation use are among the most fascinating of management problems. Much of the Everglades and the narrow fringes of coral in tropical parks are both primary interfaces and highly productive ecotones. It is important to note that if the sea level were to rise more rapidly, or if growth were slowed, these systems would be threatened with extinction.

Coral interfaces are important buffers and homes for many other organisms. They provide a constant buffer to coastal wave energies. Fish feed and nest in the reefs. Their complex shapes make them biologically diverse and productive. They are responsive to the sedimentary materials washed off the land but at the same time are imperiled by wastes dumped into the sea. They demand clear, evenly heated water, easily penetrated by light. The protection of coral reefs is crucial to protect masses of land subject to destructive surges and waves.

Coasts of Immobile Materials

Seemingly, the least fragile of all systems are the rocky coasts found for example on New England's coast. In fact, these rocks shelter, protect or influence the water quality both offshore and upland. The concentration of life forms and communities exposed to the sea are well adapted to, and derive their health from, the inherent variability of sea level. This adjustment to tidal stages is dependent upon a constant supply of high-quality water. Deviations from this quality such as oil spills, sewage release, etc., constitute the major threat to these natural systems.

Summary

Management of marine systems and coastal areas must recognize that change is crucial to the maintenance of a system in harmony with nature. A sound management strategy should be careful to include acquisition and control of lands and waters adjacent to coastal interfaces to make sure that the integrity of the area is maintained. Acquisition of interface and ecotones should be a top priority. A recognition of the interrelatedness of these regions should be reflected in management decisions. There is a critical "domino effect" in any action taken to alter existing natural systems. Sometimes these actions must be taken. However, it is important that the long and short-term implications of any action be carefully considered.

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This article was excerpted from a study on dune stabilization prepared for the National Park Service, Office of Natural Science.

Protecting Waterbirds

by Paul A. Buckley and Francine G. Buckley

The following article is derived from a monograph prepared for distribution in the National Park Service and Fish and Wildlife Service titled: "Guidelines for Protection and Management of Colonially Nesting Waterbirds." Copies of the full text are available by writing to the authors c/o National Park Service, North Atlantic Regional Office, 150 Causeway St., Boston, Mass., 02114.

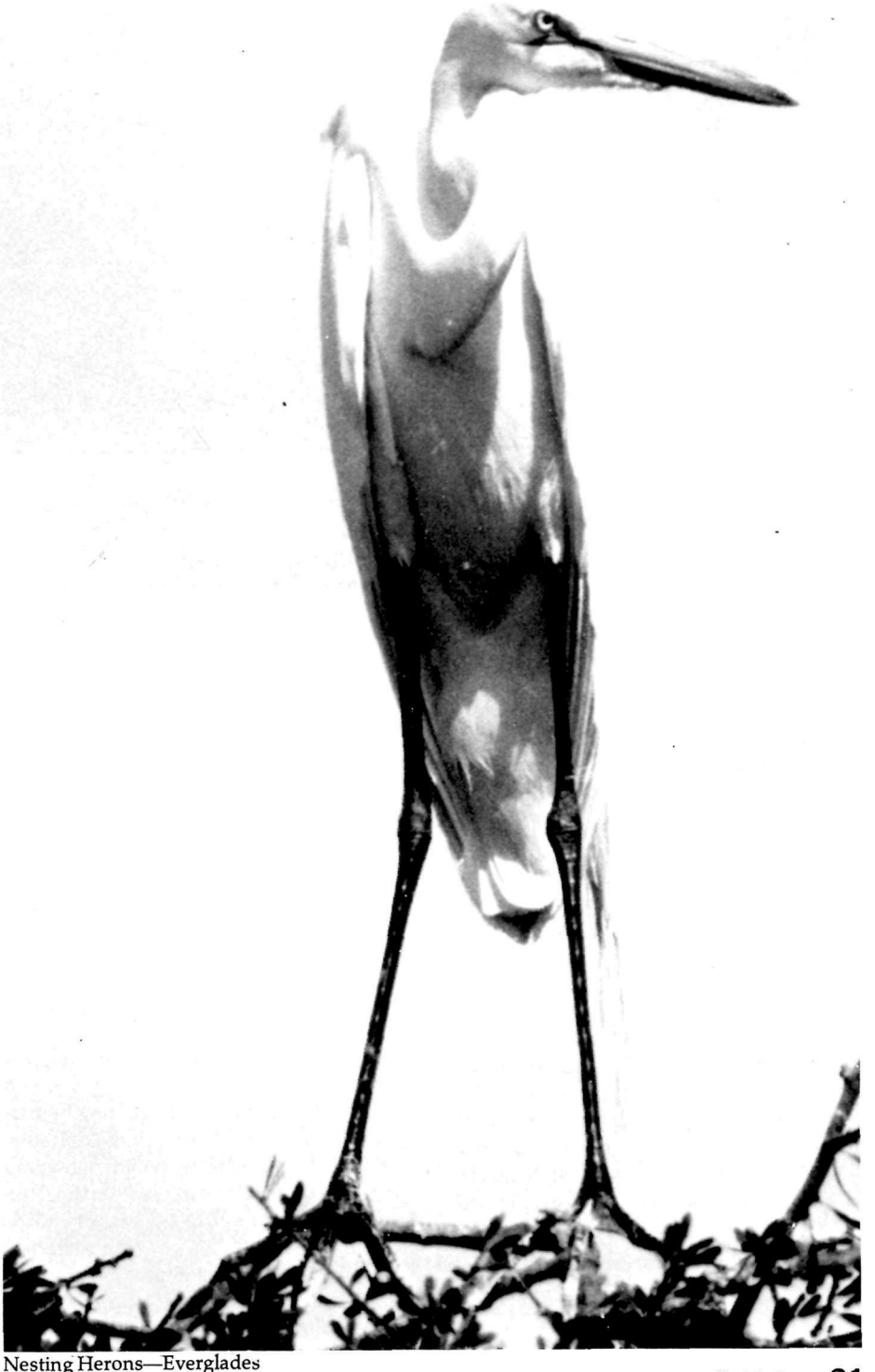
There was a time in our history at the turn of the century when terns and heron and other waterbirds were in danger of almost total extinction. Thanks largely to the work of the National Audubon Society, the birds' protection was mandated and they began to reclaim their former ranges.

There are many birds whose populations are on the decline or in danger of extinction today. It is these birds (see box) whose welfare is addressed in this article.

The first recent hint of some trouble with the populations of colonially nesting waterbirds came from Massachusetts where it was noticed that Common Terns seemed to be declining despite increased protection. Pesticides were thought to be the culprit but were soon largely ruled out. Then workers in other areas along the Atlantic Coast became aware that despite a thriving appearance, many colonies were in fact producing fewer flying young each year, and that traditional colony sites were being abandoned one after another.

Other, more subtle, trends were soon uncovered: birds were concentrating in fewer and fewer, larger (and hence more vulnerable) colonies; colonies were shifting from beachfronts and other natural sites to man-made areas such as dredge spoil deposition islands, roof tops, and man-made and maintained impoundments; and sometimes startling changes in habitat preferences for colony siting were taking place.

In the early 1970's, workers in refuges and parks noticed that there was a distinct and potentially threatening impact of human activity on colonially nesting waterbirds, thus, Interior Assistant Secretary Reed asked for guidelines for the protection of these birds. This report provides some indication of ways to survey and protect these threatened colonies of waterbirds.



Nesting Herons—Everglades

Mixed Colony of Nesting Waterbirds

Included Species*

Brown Pelican
White Pelican
Double-crested Cormorant
Great Cormorant
Olivaceous Cormorant
American Anhinga
Magnificent Frigatebird
Great Blue (incl. "Great White") Heron
Green Heron
Louisiana Heron
Little Blue Heron
Black-crowned Night Heron
Yellow-crowned Night Heron
Cattle Egret
Reddish Egret
Great Egret
Snowy Egret
Glossy Ibis
White-faced Ibis
White Ibis
Scarlet Ibis
Wood Stork

Roseate Spoonbill
Great Black-backed Gull
Herring Gull
California Gull
Ring-billed Gull
Laughing Gull
Franklin's Gull
Little Gull

Gull-billed Tern
Forster's Tern
Common Tern
Roseate Tern
Arctic Tern
Least Tern
Sooty Tern
Royal Tern
Sandwich Tern
Caspian Tern
Black Tern
Brown Noddy
Black Noddy
Black Skimmer

**The list excludes Pacific Coast Waterbirds.*

A Rationale for Protection

The protection of many of the birds is mandated by Federal and state laws because they represent an important element in the ecosystems in which they occur (see below). Perhaps the most graphic example is the potential condition of our beaches if there were no gulls to clean them.

Colonial waterbirds too are probably responsible for a significantly large but as yet unquantified exchange of energy between land and water biotas. They supply enormous amounts of fertilizer to beaches and coastal uplands, and the resulting vegetation often serves to stabilize sand dunes and other coastal soils against erosion and blowouts. Likewise, heronries nourish plant successional stages and in many places, no doubt accelerate succession.

Because they are at the top of the food chain, these birds are particularly vulnerable to pollution and to prey declines. They can be used as indicators or early warning detectors of both conditions. If they are to survive successfully in their man-changed environment, they need special protection as top predators.

Aside from their value ecologically, they offer man a source of beauty in sight and sound, an opportunity to learn about our environment and our ecology by studying their life patterns. Just as many managers of coastal areas rely on these bird populations to help clean their beaches, fishermen use terns and gulls to locate schools of bait fish being preyed upon by larger sport and commercially valuable fish. Through them, we add to our enjoyment of fishing, of eating.

Building a Better Understanding of Waterbirds

It is difficult to help protect a set of species if you are not familiar with some critical biological features of the birds and the implications these characteristics have on the management and protection of such colonies.

Most colonially nesting waterbirds are densely packed into only a few small areas while breeding. This is quite natural, but it makes them vulnerable to a single disturbance. Man's need for the land has made breeding difficult. For example, in Long Island, N.Y., where the Common Tern frequently nests in large colonies, of the

Nesting Pelicans—Padre Island

four largest colonies surveyed in 1975, one was non-productive (on a salt marsh), another is threatened by sewer pipe construction, and a third sits between traffic lanes at Jones Beach State Park.

To gain a better understanding of the specific situation in any given Federally-administered area, the colonies of waterbirds should be censused on a larger regional basis to give a regional perspective to the status of the birds.

Human disturbances may well change the species' breeding habits and habitat preferences, patterns which should be closely observed so that management practices can be adapted to those changes. It is important to remember that many species will *not* renest that year if disturbed, or if a colony is forced to move. By the same token, research has demonstrated that colonies will hold their ground more if young are present, least during courtship and nest-site selection states. Once they have moved, an entire colony may not be able to produce any eggs or young after initial reestablishment. Those animals at the edges of their geographic ranges suffer the greatest stress, more so than those at the center of the geographic range. There are regional "seed colonies," which by virtue of their size produce excess individuals which then establish new colonies. These groups need even greater protection than other colonies. The distinction between seed and other colonies can, however, be made only by banding the birds and following their movements closely. The numbers of breeding pairs within a colony is related to the reproductive success of the colony. There appears in many species to be a minimum number of colony individuals below which reproductive success of the colonies declines rapidly. Regardless of the size of the colony, all species require extensive and reasonably near-by protected areas for feeding, resting, bathing and other non-breeding activities.

What is the Status of Waterbirds in Your Area?

Armed with some insights into the generalized patterns of behavior of colonially nesting waterbirds, how does one determine what kinds of management decisions to take regarding these threatened populations?

There are four basic activities which aid in determining the best policy to adopt:

1. Surveying to locate active colonies
2. Censusing to determine numbers of each species within a colony
3. Monitoring the colonies throughout the breeding season
4. Evaluating the colony's health and productivity.

Locating colonies is not always easy, they are not always obvious. Densely packed Royal Terns on a small spoil island and White Ibis nests clustered in mangroves are not likely to be missed if one is in the area, but scattered, sitting Least Terns, isolated Great Blue Heronries in the tallest treetops in densely wooded swamps, or Glossy Ibis colonies on the ground in thick *Phragmites* patches are all too easily passed by, unnoticed.

Several clues can be helpful in approximating colony locations, *but the presence of nests and eggs is always the only verification of a breeding colony.*

Previous colony sites, determined from the literature, local experts or oral tradition (not to be discounted), should always be investigated first. Even if unoccupied early in the season, they should be rechecked periodically. *All surveys should begin by checking old colony sites.*

Indicators of active colony sites include the following, with much variation depending on species:

1. Adults in breeding plumage persistently flying over, into, or around one location in suitable habitat.

2. Persistent clustering of adults in one place above the high tide/high water mark, especially true of gulls, terns and skimmers.

3. Breeding-plumaged adults carrying food or nest material (twigs, sticks, shells, grass, etc.) to one location.

4. Courtship behavior and displays, or copulations, in/on/over small areas.

5. Roosting at night in one particular area, especially by herons and ibises.

6. Adults dive-bombing persons or animals when they intrude on specific areas in suitable habitat.

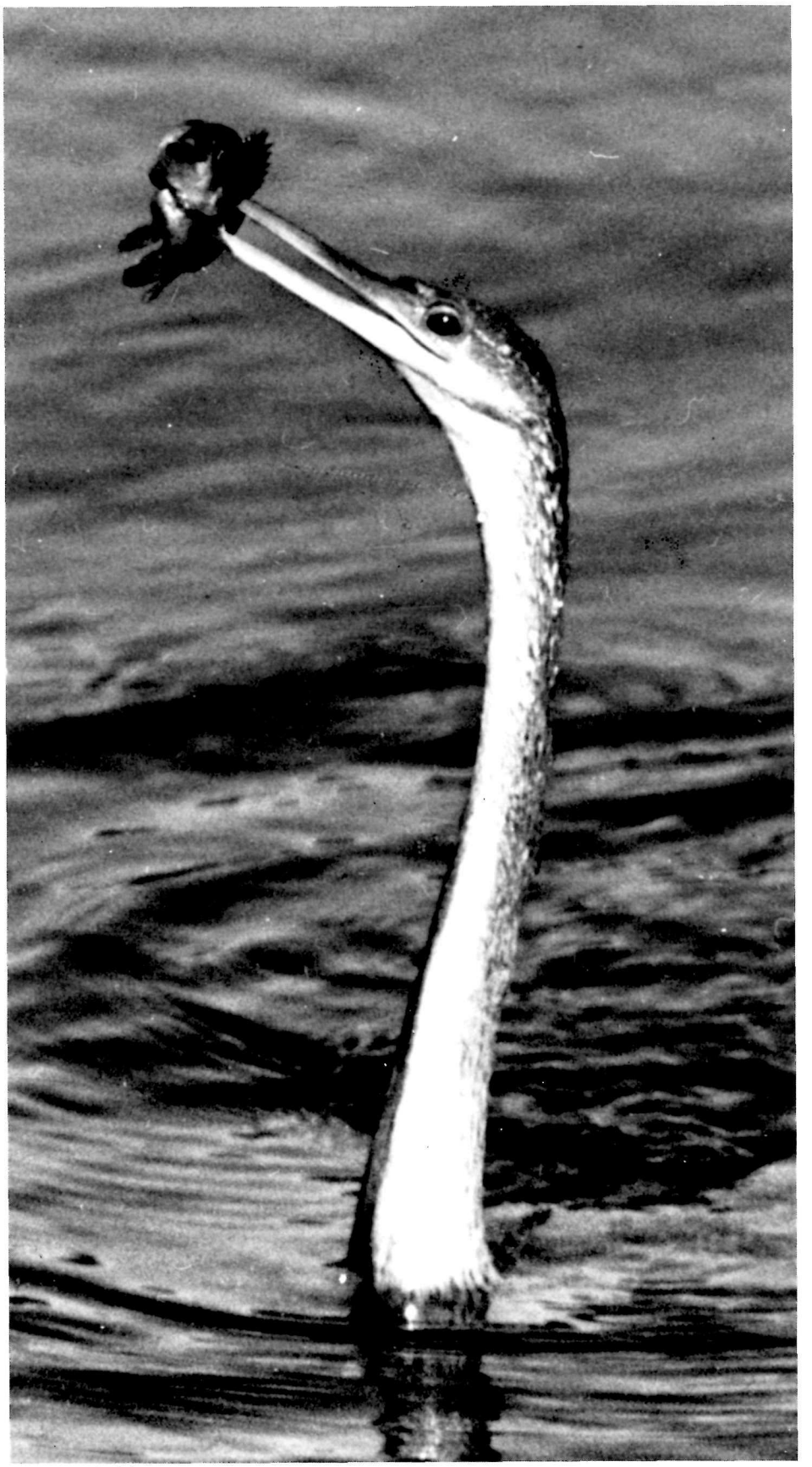
7. Clusters of adults regularly spaced out from one another on the ground (terns, gulls, skimmers) or in trees and bushes (herons and ibises), especially other than at dusk.

8. Whitewashed and/or smelly areas with suggestions of nests, or nest 'scoops' and many birds' footprints.

9. Clustered adults sitting on the ground or in trees and bushes and allowing unusually close approach before flushing and then returning to the same spots.

If Nesting Areas are Disturbed—The Impact

Colonially nesting waterbirds whose colonies are disturbed by any of the items enumerated below can suffer reduced fertility, fecundity or viability. If there is a disturbance by other species, the nest material is often stolen. Disturbances may result in agressive protective behavior against the intruder resulting in neglect of eggs or young chicks, leading to hatching failure or death. Eggs or chicks may fall or be kicked out of nests. Whole colonies may be abandoned, severe changes in individual or group behavior may occur. Abnormal predation patterns may appear. Finally, a species entire range may contract as the result of a disturbance.



American Anhinga

What Kinds of Disturbances are Potentially Dangerous?
Experience indicates that most colonial waterbirds seem to habituate to the presence of fixed-wing aircraft, however, the activity of helicopters is far more dangerous. Sonic boom seems to have a serious effect on the breeding habits of some species. In 1969, repeated sonic booms over the Dry Tortugas caused total breeding failure of 80,000 plus pairs of Sooty Terns, apparently because embryonic membranes were vibrated loose. Sooty Terns are ground nesters. However, interspersed among the Sooties were 2–3,000 Brown Noodies, nesting in low trees. That species exhibited virtually no deleterious effects of the shock waves.

Off-road vehicles are potentially dangerous if they run through a nesting area damaging nests, forcing birds to abandon their colony. By the same token, pedestrians, boaters, hunters, fishermen and other individuals exploring the wilds may accidentally stumble on a colony and run the risk of destroying a colony and possibly endangering their own personal safety as protective parents dive-bomb them. Pets are an even more dangerous problem—particularly loose dogs who run amuck through colonies.

Managers of wildlife refuges may be familiar with people who find it sporting to band birds as a kind of recreation. The damaging effects of "ring-and-fling banding" on nesting birds should force the end of this sport. Other hobbyists, such as nature photographers and egg hunters must be discouraged from disturbing colonies, along with the more menacing poachers.

Both dredging activities and mosquito control efforts, which may be well-intentioned, should take into account the sites selected by nesting waterbirds because such massive changes in the environment can do a great deal of damage to the birds.

Once aware of the potential dangers of such disturbances, there are a number of steps which can be taken to prevent such behavior. Before defining suggested guidelines for protection, it is necessary to caution managers of areas with colonially nesting waterbirds not to try and undo a wrong by moving nests or eggs that appear to be exposed or vulnerable, to mark eggs, replace stray eggs or add eggs to nests (many species recognize either their own eggs or nests, and will have nothing to do with strangers) and never handle young birds, especially to place them back in their nests. Finally, never attempt to alter the physical details of a nesting setting.


American Anhinga—Everglades

What Can You Do to Protect Colonies from Disturbances?
A comprehensive program of interpretation through lectures and tours, leaflets, exhibits, signs, news releases and other public media coverage will help to educate the public. The following guidelines for informing and controlling the movement of the public near nesting sites will help to prevent the decline of populations of the colonially nesting waterbirds listed in the box on p. 00:

Suggestions for Restricting Public Movements to Protect Waterbirds seasonal or area closure to off-road vehicles (orv)

- After determination of dates by local experts, close off entire areas to all ORVs, but soften impact by use of education exhibits. To maintain good faith, remove closure as soon as colony has been vacated.

- Attempt to reduce to the bare minimum all official ORV traffic.
- Restrict essential ORVs to carefully marked tracks during critical periods.
- Do not allow ORVs to stop or discharge passengers (except in emergencies) within 1000 feet of active, posted colonies if at all possible.
- Forbid foot traffic within 1000 feet of active, posted colonies.
- Pets must remain under the physical control of ORV occupants or owners at all times, and must not be allowed out of the ORV within 1000 feet of colonies. This condition should be printed on all ORV permits. Violation subjects permittee to automatic permit revocation.
- Trail bikes, snowmobiles, all-terrain vehicles and other self-propelled devices not easily restricted to clearly defined tracks should be totally banned from areas with active colonies in season. The temptation to stray from tracks is too great and effective enforcement is generally impossible.
- To avoid ecological damage, forbid ORV driving on dunes, in marshes or along the beach above the high water line; exceptions to the latter should be made where no other course is possible, but vehicles must be then confined to clearly marked tracks.
- Prohibit night use by visitors anywhere near the colony.

seasonal or area closure to pedestrians.

- Restrict foot travel within 1000 feet of active colonies.
- Be certain all colonies are clearly marked and posted.
- Require written permission from area manager before a closed area can be visited on foot.
- Enforce same strict pet regulations as for ORVs near colonies.
- If foot travel must be allowed near colonies (e.g. on narrow beaches), keep all persons as far away as possible, and on one narrow path. Discourage group use.

- Depost colonies as soon as birds depart them.
- Prohibit night use of area by visitors.

signs and posting

- All colonies should be at least posted with some sort of admonitory signs. Better still are combined educational/admonitory signs.
- Effective signs at Cape Cod National Seashore had stencilled silhouettes of birds (terns) feeding young; similar signs at Gulf Islands National Seashore were equally effective.
- Sample wordings include:

THESE DECLINING BIRDS ARE HARMED BY ANY DISTURBANCE

PLEASE KEEP AWAY

and

TERN NESTING AREA

KEEP AWAY

- Whenever possible, they were jointly signed by the National Park Service, the Massachusetts Audubon Society and the local town Board of Selectmen. Such multi-agency backing is enthusiastically recommended.
- If the area indicated, bilingual signs should be used.
- If no fencing is used (see later section), place a perimeter of warning signs no closer than 50 meters or 150 feet from the colony's edge. They should be spaced about 50 feet apart.
- Traditional colony sites, especially of species that are susceptible to disturbance during courtship and nest site-selection (such as skimmers and many terns), should be posted with signs well before their arrival. Consult local experts for dates. Heronries can usually be left posted all year long, as they are generally in/on places where off-season multiple use is rare.
- Beachfront, multiple-use area colonies should be deposted immediately after the birds vacate the colony.

Blue Heron—Assateague

- Nuisance signs such as DANGER: POISON IVY or DANGER: TICK BREEDING AREA or DANGER: RATTLESNAKES (COTTONMOUTHS, etc., are effective self-policing devices when placed in/on/near colonies *where the described situation exists*.
- As a general rule, if a colony has been active in the last five years, post it annually for another five. But if in any year the birds fail to return within four weeks of their normal time, depost the colony immediately.

symbolic fencing

- When protection beyond admonitory signing is needed, the next level we recommend is "symbolic" twine fencing. The psychological effect is virtually the same as genuine fencing, and this is cheap, easy to take down and convenient to store.
- It is generally not needed in dense vegetation or on islands, where signing plus natural vegetation or the perimeter of the island may do as well.
- We *do not recommend* using any kinds of wire for many reasons, notably safety; or using light weight cords such as kite string as they break or disintegrate too easily, and entangle birds readily.
- Experience at Cape Cod strongly suggests using "Mason's Twine," readily available in hardware stores and costing only about $40/mile. It can easily be rewound onto old chain reels for storage.
- The string is tied about 4 feet high onto 2 inch square wooden, 5-6-foot long fence posts buried about two feet deep. Hard substrates would require different anchoring. Posts are about 50 feet apart.
- To the string are attached strips of fluorescent or dayglow "surveyor's tape" every 10 feet for visibility, with about 12 inches left hanging downward. Pedestrians and vehicle operators can thus see the barrier at some distance.

- The twine must be retightened every 7-10 days (especially in the first 2-3 weeks until all slack is taken out of it) or it sags to the ground, thereby rendered ineffective in preventing trespass, but frequently snagging flying birds.
- The twine fence should, whenever possible, be placed about 50 meters or 150 feet from the actual edge of the colony as a buffer against disturbance.
- Erection of the fence while birds are in the colony exacts a toll in disturbance. However, that one controlled disturbance is a price well paid for the prevention of many later, uncontrolled disturbances.
- The buffer zone distance is not hard and fast, and common sense will occasionally indicate departure from it. The fence at Cape Cod sometimes had to be placed up to the very edge of the colony, with no buffer zone, so that at high tide permitted vehicles were able to traverse the beach safely.
- As soon as the colony is vacated, remove the fence and signs for storage. Symbolic fencing especially would lose its effect if maintained longer than needed.

driftwood fencing

- Highly effective on beaches with concentration of driftwood.
- Use to deflect or direct pedestrian or vehicular traffic.
- Chaining together timbers for a more impervious barricade also works well.
- Experiment with the use of other, on-hand natural materials.

snow fencing

- When a real physical barrier must be used, ordinary slattedwood snow fencing is recommended for many reasons. It is most effective when it is free to wobble when pushed.
- It too should have a buffer zone, especially so because wandering young birds need much room. With a symbolic fence they have it, but some birds cannot fit through snow fencing. If there is no cover inside, they may die.
- Wooden snow fencing is remarkably effective at collecting drifting sand, so be sure to remove it for winter storage at season's end.
- New plastic forms of snow fencing are also good at collecting drifting sand, but do not keep out unwanted animals, including man, who hops it with ease.

battery-operated electric fencing

- Suggested only for extreme cases where pathological predation threatens a colony.
- Is apparently only effective against certain quadrupads (foxes, raccoons, weasels, opossums, dogs, cats, and perhaps goats and pigs).
- Be certain to adequately warn people of electric shock hazard.

boat landings.

- If colonies are on islands accessible only by boat, post them closed to all persons for the proper period, except by special permit.
- Whenever possible, place signs out in the water 50 meters or 150 feet from the shore of the island. Ideally, boats should be kept at least 500 feet from occupied islands.
- As soon as the birds depart the island, depost it.
- During the breeding season, all pets are forbidden on islands with colonies.
- Generally the same rules apply as for mainland colonies.

aircraft

- Rules for aircraft operation, including helicopters, should be established for all parks and refuges.
- All colonies should be placed off-limits, with ceilings established for *all* aircraft.
- If disturbance by aircraft is regular and unavoidable, such as near airports, do not be concerned. The birds will habituate to them quickly or leave.
- Cooperative agreements with adjacent military bases may be imperative to prevent sonic booms, repeated low overflights, or buzzing of colonies.

pets

- Establish and use leash laws to keep all pets away from colonies.
- Extra enforcement of leash laws within one-half mile of a colony, such as was done at Sleeping Bear Dunes National Lakeshore, will solve many pet problems.
- Repeat offenders should be warned their animals will be removed and destroyed; the threat should not be a hollow one.
- Pet owners dumping unwanted pets should be fined heavily.
- Pets in ORVs and on boats are especially vexing and difficult to control. Additional attention should be paid to advising their operators of the laws.

bird banders and photographers

- Should be allowed in colonies only by special use permit, with the number, duration and other details of visits carefully controlled.
- All banding projects should be supported by a full proposal and justification, and should be approved by area managers and region/subregional offices.
- Recreational banding (not being done for specific scientific or management purposes) should be flatly forbidden in all cases.
- Limits should probably be placed on the total daily time both banders and photographers can spend in a given colony, and enforced strictly. Consult experts on the species involved for details.

scientists

- All scientific study in colonies should be by special-use permit only, following approval of a technical proposal by area managers and regional/subregional office staff. This can be short, but must be precise.
- All support personnel must be supervised carefully, especially if inexperienced.

- Additional permits should be required if banding is to be done.
- Students should be supervised by established, proven-to-be responsible scientists.

mosquito control activities

- All must be by special-use permit.
- Guarantee must be obtained in writing that no work will be done near colonies, which will be marked on maps given control personnel.

dredging activities

- Most of the adverse effects of dredging can be obviated by two procedures:
- Require all dredging activity proposals to indicate their awareness of the existence of known waterbird colonies;
- Forbid dredging or spoiling activities within appropriate dates in the vicinities of colonies;
- Inasmuch as dredging permits must be obtained from the U.S. Army Corps of Engineers, that agency should receive regular notification, probably at least twice a year—at the beginning and end of local breeding seasons—of the location, composition and health of all known waterbird colonies in the local Corps' administrative area;
- Monitoring of dredging contractors' work by the appropriate agency is also essential.

boardwalks and towers

- Can effectively control visitors while allowing them view of the colonies.
- Should not be placed closer than 250 feet from active colonies.

use of vegetation and natural features

- Naturally occurring noxious or visitor-limiting plants such as poison ivy, catbriars, etc., can be encouraged to protect colonies.
- Judicious plantings of prickly pear cactus, roses, etc., can be used the same way.
- Ditches can be dug, or natural channels deepened, to prevent colony access.

designation as special protection areas

Significant measures of protection of areas harboring active colonies of waterbirds can be achieved by various designations, where appropriate:

- Research Natural Areas
- National Natural Landmarks
- National Environmental Study Areas
- National Environmental Education Landmarks
- Wilderness Areas, etc.

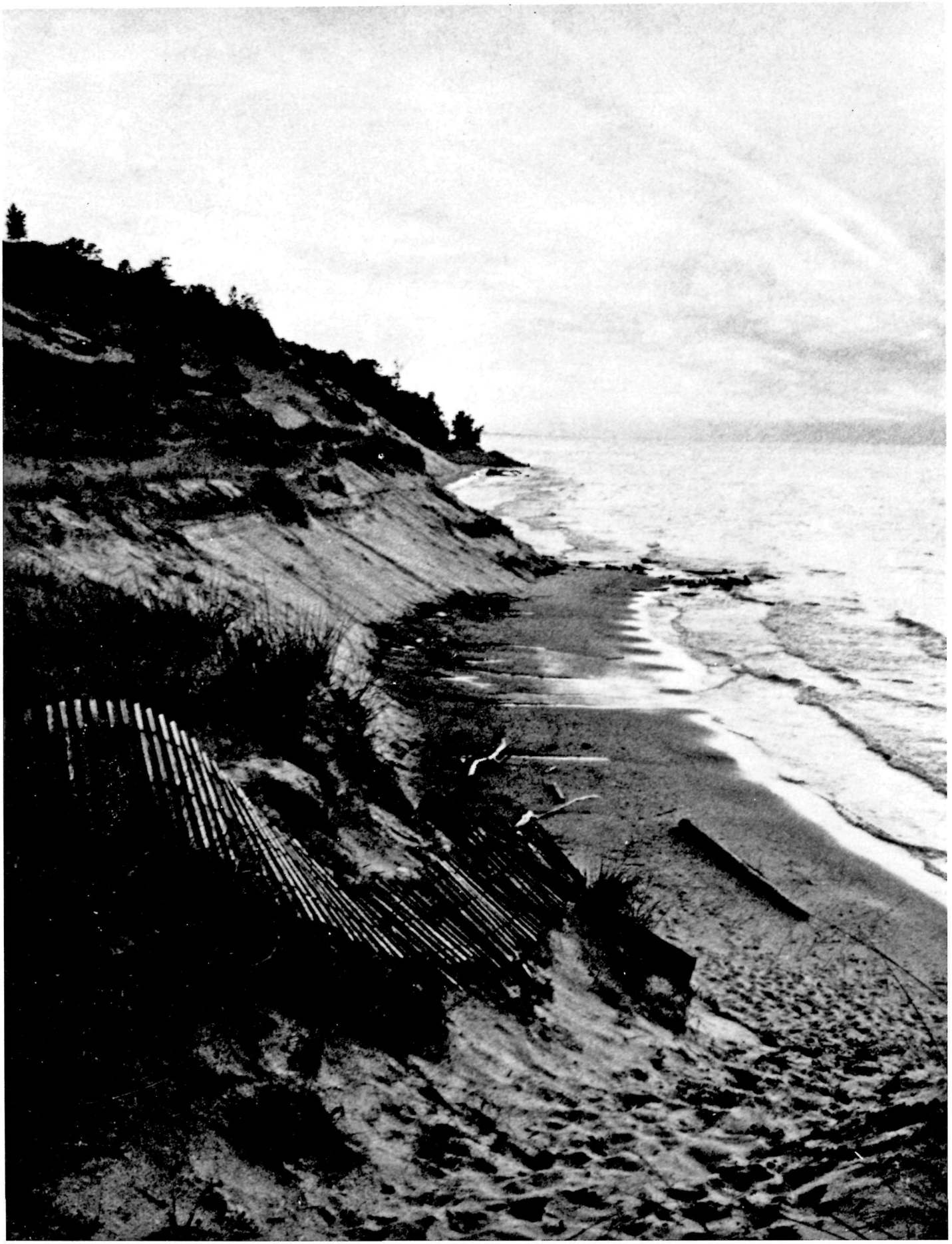
enforcement

When all is said and the foregoing done, real last-ditch protection of colonies will be achieved only by regular patrols and apprehension of flagrant offenders. The public must be convinced that while we prefer to talk softly, we will if necessary fall back on law enforcement to emphasize our determination to protect these resources.

Paul A. Buckley is Chief Scientist, NPS, North Atlantic Region. Francine G. Buckley is Research Associate at Monomet Bird Observatory.

Roseate Spoonbills

Common Terns Nesting



A Look At A Retreating Shoreline

by Paul Godfrey

An understanding of the dynamic changes occurring in our coastal areas offers an opportunity to view elements of nature responding and adapting to constant stresses. There is a fascinating give and take which occurs around the retreat and shifts in our shoreline.

Dr. Robert Dolan and his associates (myself included) have covered some of the issues which need to be addressed regarding shoreline management, particularly as they relate to the boundaries between ecosystems (see page 16).

In this article, we will examine the effects of shoreline erosion on the land, particularly our eastern coastal park areas: Acadia National Park in Maine; Cape Cod National Seashore in Massachusetts; Fire Island in New York; Gateway National Recreation Area in New York and New Jersey; Assateague Island in Virginia-Maryland; the Outer Banks—Cape Hatteras and Cape Lookout National Seashores in North Carolina; Cumberland Island in Georgia; Cape Kennedy National Seashore in Florida and Mississippi; and Padre Island in Texas.

The information here is based on research conducted by the National Park Service Co-operative Research Unit at the University of Massachusetts which has helped to clarify the ecological consequences of shoreline retreat or erosion.

Historical Background

To adequately understand the dynamics of this retreat, one must first think about the dynamic stability of coastal lands—a constantly changing system which has been responding to the rising sea since the last ice age, 5,000 years ago when the sea was at its lowest level. At that time, sheets of glacial ice covered the northern hemisphere and the sea was 130 yards lower than it is today. As the ice melted, the water returned to the sea, raising its level and flooding what was once dry land.

The land masses near what is now our northern coastline were depressed under the weight of the ice. These land areas are today rising while lands to the south are sinking in a sea-saw fashion known as isostatic change. Changes in sea volume are called eustatic change.

The sea is rising more rapidly than the land, in effect, drowning the land. Aside from this constant shifting, natural events such as storms at sea, hurricanes, cyclones, winds, waves and storm surges all contribute to constant flux in coast environment.

Response to Change

The sand beaches all along the eastern coast are constantly responding to change. Barrier beaches such as those found at the Outer Banks and on the barrier spits of Cape Cod retreat by littoral drift overwash (or the rush of sand and water over land areas), inlet dynamics and wind.

Littoral Drift

Moving sand carried along the beach by waves is called littoral drift or longshore transport, otherwise known as a "river of sand." The source of this sand is often the updrift portion of the barrier itself. At Cape Cod, the source is also glacial sea cliffs When the updrift part of the barrier loses sand, that is called erosion. The sand doesn't disappear, it usually ends up on the downdrift portion of the beach, growing across an inlet in a process called accretion or accumulation of sand. At the accumulating end, dunes form and can build up into substantial dune lines so large that little overwashing occurs. Usually, the accreting occurs at the south or west end of barrier beaches along the east coast.

There is a natural tendency to ignore the accreting end of such a body of sand and concentrate on the eroding end. The danger is that the sand continues to move. Soon man attempts to stop this movement by building groins or jetties at right angles to the beach, causing problems to multiply. Severe erosion occurs on the downdrift side of the jetties or groins with accumulation on the updrift side. The beach begins to look scalloped from above. The more groins that are installed, the less the sand can move. This means that beaches on the downdrift sides of the structures begin to erode severely and may disappear. The waves continue to move whatever sand they can and because of longshore transport, may wash away entire beaches.

Overwash

Barrier island migration also occurs through the process of overwash—the movement of sand from the beach and foredunes across a barrier area during a severe storm. Simply put, the storm surge rises up, over the ocean beach, flooding the dunelines and regions behind the dunes with sea water and sand. The flood leaves a characteristic layer of new sand on top of the earlier surface: thus each successive overwash has the potential to build up the barrier over time.

After Effects

Visitors to areas which have experienced an overwash may be surprised at the appearance of the area. It looks as though all the vegetation was destroyed or eroded away. What is usually the case is that the vegetation was buried by the overwash, sometimes as deeply as two feet. The most exciting aspect of the overwash process is the way natural vegetation on these barriers recovers from the burial.

The grasses and sedges, in fact the majority of plants in these communities, can grow up through the new layers of sand. It appears that burial seems to act as a stimulus to growth (this is particularly true of salt meadow cordgrass). Studies by the Co-operative Unit at the University of Massachusetts have found nearly total recovery of a grassland community within one year of an overwash that brought in one foot of sand from the ocean. Burial of a depth of up to three feet does not seem to stop the regeneration of cordgrass plants.

The regrowth of plants acts to stabilize the sand and prevent loss to wind erosion. The vegetation also acts as a trap for the next overwash, serving as a base from which the next new community develops. From what we have learned, overwash on these barrier beaches is a natural event for which the vegetation is adapted. It is the primary way in which barriers have been built.

In some cases, overwashes push sand all the way across a barrier beach to the lagoons behind. Sand in these intertidal zones becomes substrate for new salt marshes, making a substantial contribution to the organic production of the estuary behind the barrier beaches. Some marshes are buried by overwash and new ones are created, usually more productive than the old ones.

A good indication that the barriers have been retreating is the layers of old salt marsh peat which can be found sticking out of the beach on the ocean tide at low tide. Even when older communities have been buried, and perhaps completely changed, the ecosystems of the barrier beach have not been destroyed, merely shifted.

Inlet Dynamics

Sand moves through a barrier beach via inlets, common features along the east coast particularly south of Cape Cod. Temporary inlets are formed during storms which breach the barrier and create openings to the lagoons during storms which breach the barrier. The inlets create openings to lagoons and bays behind the beaches. Unless there is a major river discharge behind them, these inlets eventually close. But while the inlet is open, sand moves through it and is deposited on the inside of the barrier in a large, fan-shaped shoal system (flood tide delta). The sand is carried in by littoral currents to quieter waters behind the inlet. Sand can also be carried out during the ebb tide and create a

similar delta in the ocean off the inlet. In most cases, the general movement of the sand is inside. Soon extensive shoals, dangerous for boaters, build up. Eventually, the inlet fills with sand and closes.

Former shoals exposed at low tide eventually become highly productive salt marshes. Those below the tide line support underwater grass beds. These old inlets become very important parts of the estuarine system, providing outstanding habitat for shorebirds because the new sediments are ideal for the marine animals on which they feed. Old inlets along the barrier beaches of the east coast can be located by the delta-shaped pattern of marsh islands behind the barrier.

Old inlet deposits appear to be the most important sources of marsh substrate behind a retreating barrier beach—moreso than overwash because it only creates a fringe of marshes. Inlets lead to extensive marshes projecting far behind the barrier beach.

Wind

Dunes are built up by winds as the sand accumulates around beach grasses. Winds can always carry sand off the intertidal ocean beach. The same plants that are adapted to overwash and some others, are adapted to being buried by wind-blown sand.

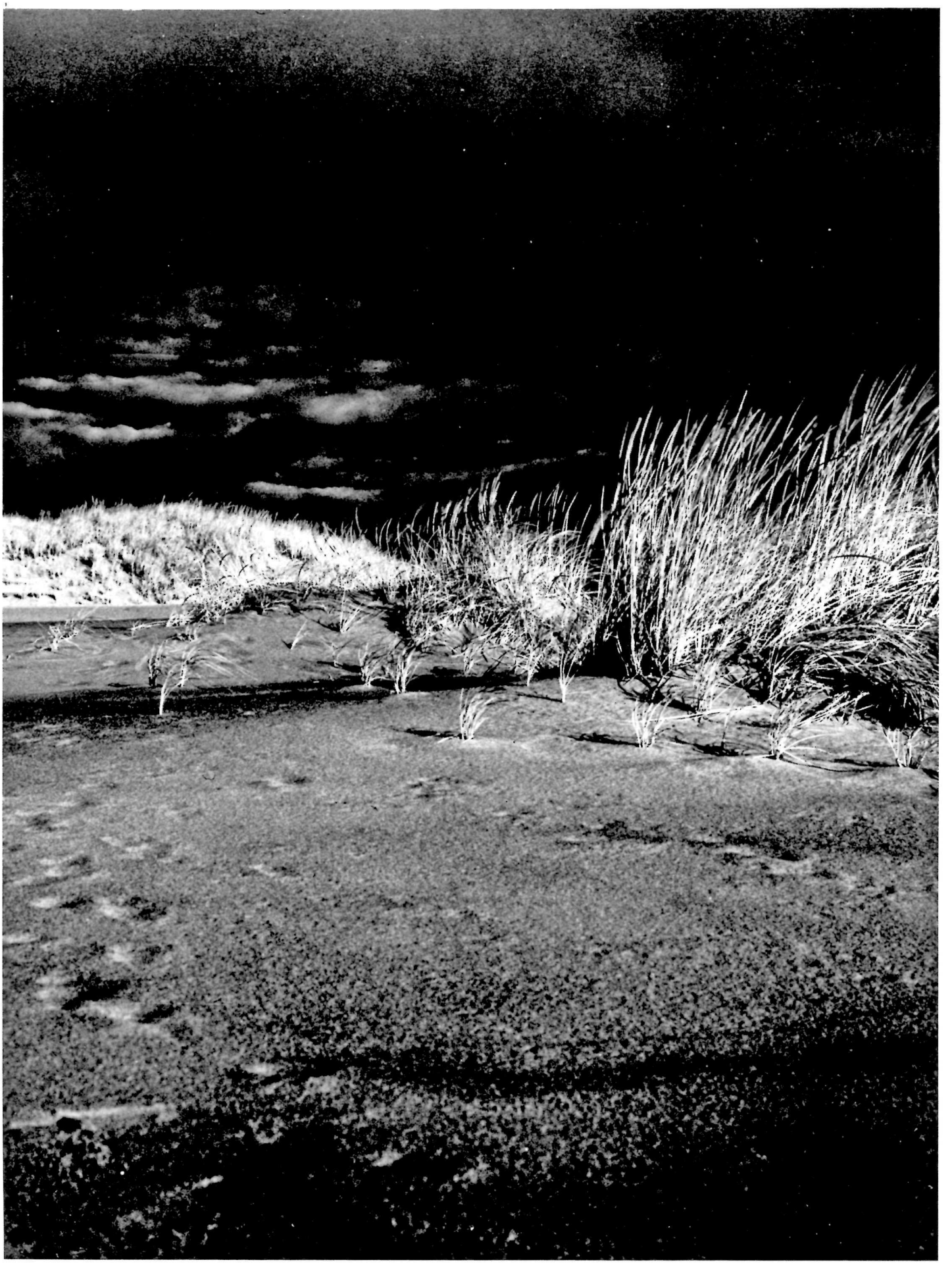
American beachgrass in the North and sea oats in the South stabilize and build dunes. Where dunes are forming on an accreting beach, whole series of dunes of different ages progress up the beach. Vegetation on the dunes reflects the degree of stability of the dune as well as its age: the oldest and most stable dunes support forests of various kinds. When the seaward dunes of a barrier are broken down as a result of retreat, the sand will be carried further into the barrier by wind and water. The migrating sand may bury existing vegetation and then uncover it. "Ghost forests" in dune areas are not uncommon sights. Eventually, the moving sand is colonized by dune plants and ceases to migrate.

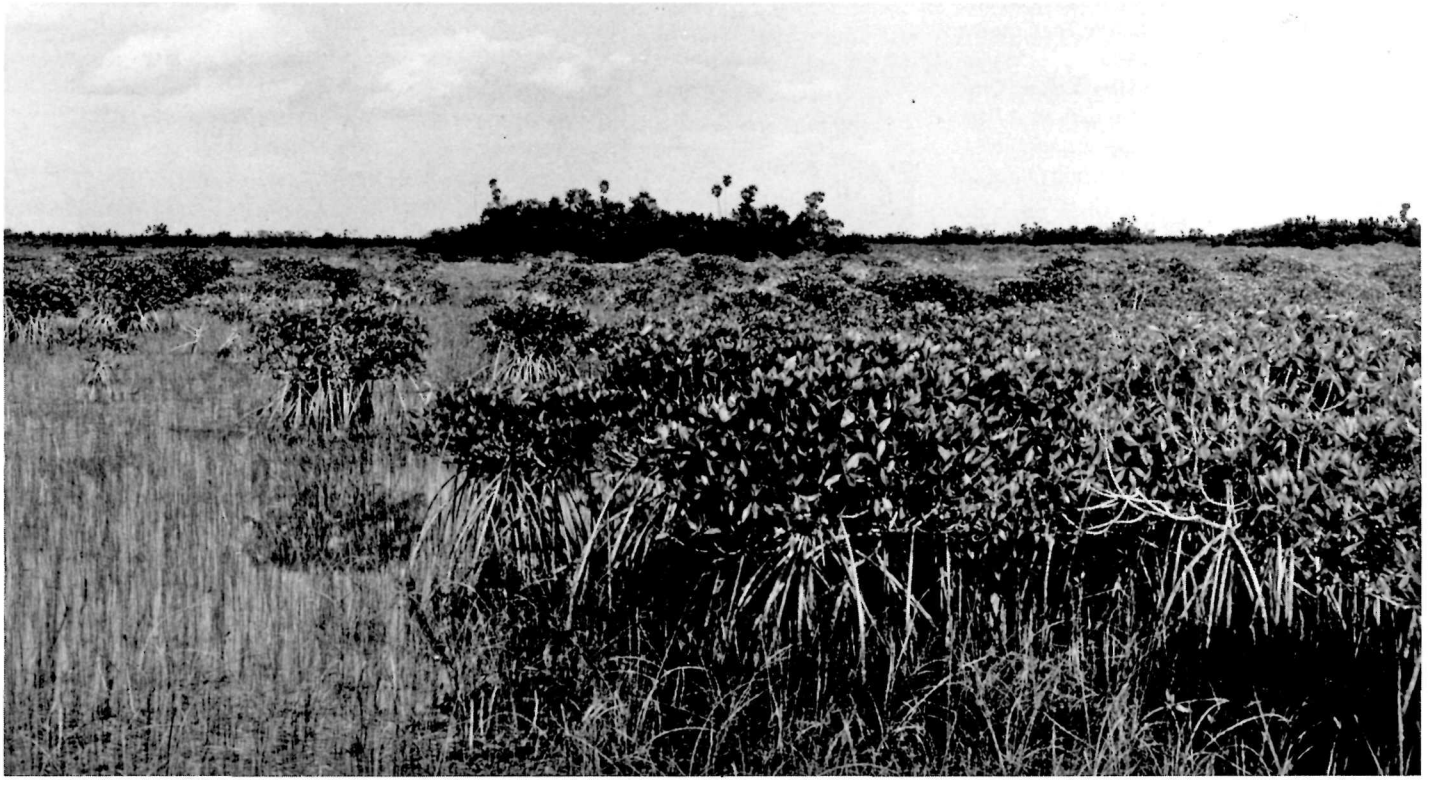
In time, other plants replace the first invaders and in a few centuries, new forests will develop on the once migrating dunes. These dunes will remain stable unless disturbed by man or the beach when it finally migrates back to them, causing a new cycle of retreat. On some barriers, overwash carries sand onto their barrier while winds tend to blow the sand back out to the beach.

Man's Intervention in Shoreline Areas

A great deal of research has been conducted regarding the artificial development and stabilization of dunes. There are many questions which must be considered if man attempts to manipulate nature. Research has shown that each area responds very differently.

Perhaps the most important issue is that without retreat, barrier beaches would cease to exist in a rising sea. They would be drowned if they did not move. It is





conceivable that barriers could be pushed up against the mainland, but some kind of estuary would usually remain behind as the mainland eroded and flooded. When the barrier migrates, so does the lagoon behind, until the point where the barrier retreats faster than the mainland floods. Then the barrier become "welded" onto the mainland shore. Whatever happens, a barrier beach is not likely to disappear as long as it can migrate up a gradually sloping plain.

There are however, variables which must be carefully monitored. For example, on the northeast coast, most barrier beaches have formed by the erosion of glacial sediments, resulting in spectacular sea cliffs and the growth of spits from those sediments across ocean water. Good examples are the Provincelands and Nauset Beach on Cape Cod National Seashore, and Fire Island National Seashore. Both systems are attached to sources of sand deposited by glaciers. If the source of sand is altered, as by measures designed to stop sea cliff erosion, the spits would be starved and begin eroding, because the sand which makes up the beaches, dunes and marshes all comes from the sea cliffs. To change the pattern, would endanger the survival of the barrier beach.

Different areas have been found to respond very differently to overwash. In a northern barrier beach, when overwash occurs (normally a rare event), the vegetation that is buried will not directly recover, even if it contains salt meadow cordgrass. Instead, drift lines, carried in by the flood waters, containing fragments and seeds of dune plants, soon send up new plants which begin trapping windblown sand. Within a short time, new dunes are forming dominated by beach grass, and there is no recovery of the vegetation from below—a very different response from that of southern vegetation. As yet we do not know why this happens.

There is however, a greater tendency for dune lines to develop on the beach in the north because of the heavy drift lines that wash up, and the wide tide range that precludes frequent overwash. Storms have to hit at just the right time to produce overwash on a northern beach, while winds are always moving sand into the dunes. The much lower tide range in the southeast allows overwash to occur whenever there is a storm severe enough to drive water over the beach.

Implications for Management

Different ecological responses to erosion require different management decisions. For example, fostering the development of continuous dune lines near the beach in New England and Georgia may be the best management approach, while such action in the Outer Banks would be difficult. We have yet to discover all the answers so that we know the consequences of every action. We do know that coastal vegetation does adapt to the physical processes of the creation and maintenance of each area. Armed with that knowledge and a basic understanding of the process and impact of littoral drift, overwash, inlet dynamics and wind, we can begin to make management decisions sensitive to the changing environment, respectful of the retreating shoreline.

Dr. Godfrey is leader of the NPS Cooperative Research Unit at the University of Massachusetts at Amherst.

The River and the City

by Theodore Sudia

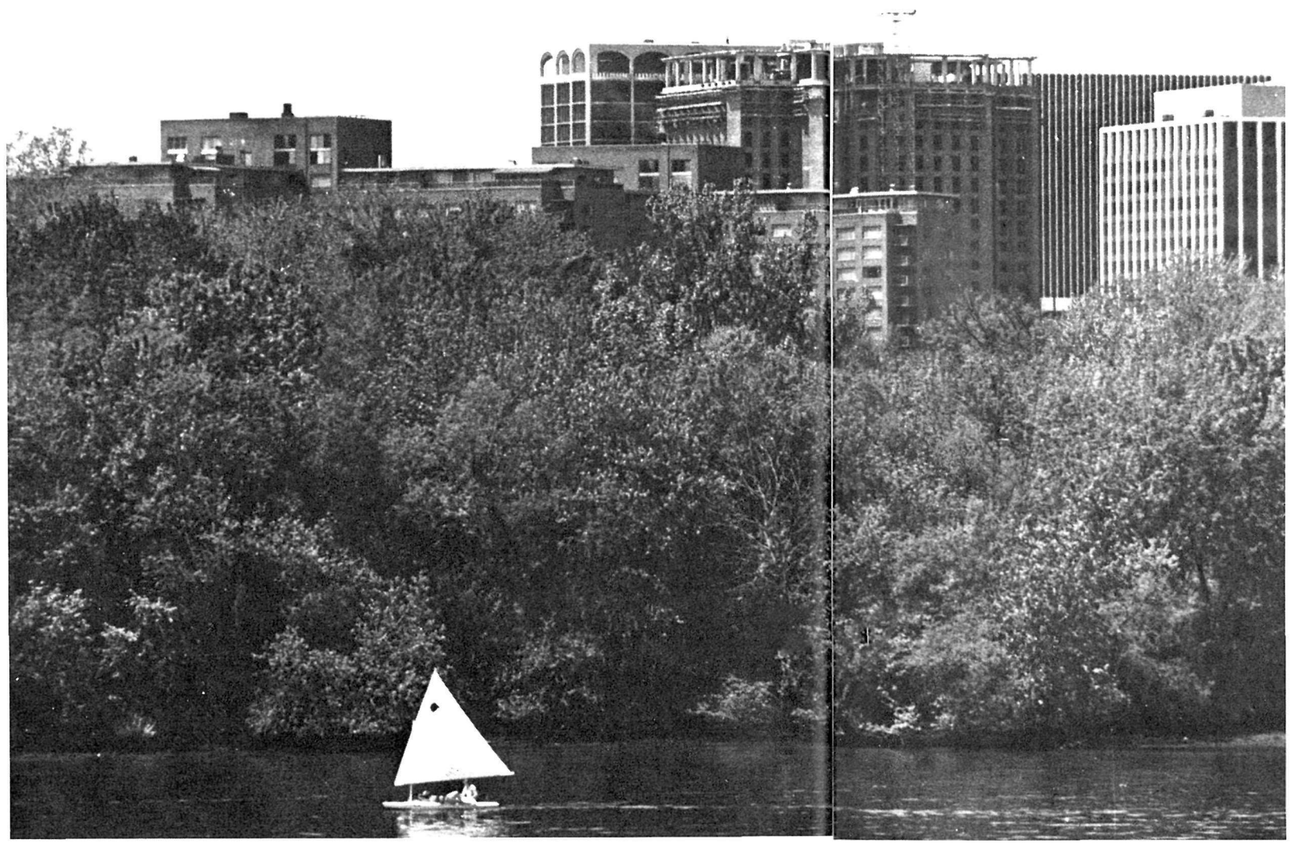
The following article is one of a series of publications on Urban Ecology including The City as a Biological Community, Technology Assessment in the City, Ecology of the Walking City, The Vegetation of the City, The City As A Park and Man, Nature, City. Copies are available from the U.S. Government Printing Office.

Most rain falls into the oceans but the lesser amount that falls on the land is absorbed by roots of plants and is transpired back into the atmosphere, is percolated into the soil, or is collected into depressions forming lakes, and some evaporates. In addition, a great deal of the rain that falls on land runs off into the streams, creeks, runs, licks, and rivers.

A river can be of any size and its depth and flow may vary from time to time. The Mississippi-Missouri River is the longest on the North American continent, while the Virgin River that runs through Zion Canyon in Utah is little more than a creek. During periods of heavy rainfall, the Freemont River in Central Utah becomes a roaring, rampaging flood, but in times of drought it can be easily forded on foot or on horseback. The rivers drain the continent, carrying silt, salts and nutrients, rocks, stones, pebbles, and gravel to the sea. The flow of the water responds to the pull of gravity and rivers follow the least resistant course.

Some of the most interesting rivers in the United States have formed as a result of glacial activity. There seems to have been a time, prior to the Wisconsin glacial period, when a great river system originated somewhere in the mountains of Tennessee or North Carolina and flowed north and westward through what is now the Kanawa River Valley of West Virginia. It crossed the Ohio River Valley, continued to the Scioto River Valley, probably connected at some point with the Wabash or the Illinois, made a loop to the west connecting the Mississippi River drainage, heading south in mid-continent.

The system of rivers that included the Kanawa River which flows through Charleston, W. Va., to the Ohio River which, in turn, flows from Pittsburgh through Portsmouth, and the Olentangy which joins the Scioto River at Columbus, Ohio, and flows through Circleville and Chillicothe to the Ohio, all resulted from the Wisconsin glaciation. The Kanawa River flows north to the Ohio in a river valley that widens as it proceeds northward, while the Scioto narrows as it approaches the Ohio River. It is an interesting geological phenomenon, for apparently the continental glacier blocked the flow of the rivers to the north, impounded the water, and formed lakes—the beaches of which can still be found—and as the glacier retreated, a sufficient amount of debris was deposited in the river valley to reverse the flow of the stream. The Ohio River Valley formed at the edge of the melting glacier and represents a new river that was cut from part of several river valleys. The drainage flowed to the southwest because in that direction lay the lowest point in the ridge of mountains where the impounded water in front of the glacier could flow. A water gap was cut at Portsmouth, Ohio, and the river continued to flow in that direction.



The Mississippi, Missouri, and Ohio Rivers drained the great continental glaciers and the entire river system of the North American continent was influenced in some way by the glaciation, to the extent that it is now difficult to determine what the land surface and the river systems were like originally.

The more common word for drainage is watershed, which can be defined as an area of land that is drained by a single stream or creek. But streams and creeks flow into rivers, so in the larger sense of watershed we really mean the river drainage; hence, the Ohio watershed, the Monongahela watershed, the Allegheny watershed, the Conomaugh watershed, and so forth.

It was an unfortunate accident of history that when the Upper Mississippi was discovered, the significance of the tributary at the confluence of the Missouri was poorly understood; for if we look at the river system of the central continent, it is obvious that the continous river system is the Mississippi-Missouri, and that the Upper Mississippi is merely a tributary of this great river system. The specifications for the Louisiana Purchase were that it should comprise all of the land drained by the Mississippi-Missouri River system. It is easy to understand why Thomas Jefferson was so anxious to acquire the port of New Orleans since it was the gateway to the continent as it was known at that time.

The Role of Rivers in Exploring America

The great river systems of the North American continent were the avenues by which the continent was explored. The search for a Northwest Passage was an attempt to find rivers or other water passages that would lead from the Atlantic Coast to the Pacific Ocean. The Northwest Passage was never found, although technically one exists when not frozen over by arctic ice. However, the rivers that rise on the eastern seaboard made it possible to push westward, a pioneering effort that eventually continued to the Pacific Ocean.

The Chesapeake Bay, the Hudson River, the St. Lawrence River, and others all played an important role in the trek West, but it was the mighty Mississippi-Missouri River with its route unhindered by falls that made possible the exploration of the continent as far as the Rocky Mountains. Canoes and sailing craft, pole boats and rafts, and other water-borne conveyances were the first means of transportation into the interior, and canal construction was essential in order to stabilize the water system, make it controllable during flood and drought, and remove the uncertainty from water navigation.

The Chesapeake Bay, which is entered by six major rivers (Susquehanna, Patuxent, Potomac, Rappahannock, York, and James) as well as many smaller rivers and estuaries, was the principal area of early settlement and the Potomac River, flowing from the hinterland near the Monongahela and Ohio River systems, became an important water route for the transportation of materials and people into and out of the heartland of the country. The escarpment of the Potomac River at Great Falls made it necessary to seek routes around the rapids, falls, and gorges and the Chesapeake and Ohio Canal had its beginnings in a company organized by George Washington, although the C&O was formally begun as such by John Quincy Adams. This combination of river and canal circumvented the falls and rapids and established a navigable route into the interior. Later, using water from the river, the C&O Canal was extended to Cumberland, Maryland, and the traveler was free of the vagaries of the river and the uncertainties of water levels. Thus, the movement of materials and supplies in and out of the interior of the continent became a fairly routine undertaking. Cumberland became an important transfer point where cargoes were transshipped into the Monongahela River system to be floated downstream to Pittsburgh and the Ohio Territory.

In the eastern United States the rivers that flow out of the Appalachian Mountains almost always cross a line of resistant rock that does not submit easily to erosion. As a result, most of the rivers flowing from the Appalachian Mountains to the Atlantic Ocean are studded with falls similar to the Great Falls of the Potomac. These falls made inland navigation extremely difficult, but water transportation was so essential to early settlers that it was considered worthwhile to construct canals bordering the rivers for safe, easy transportation routes.

The rivers and canals served as a means of transportation for many years, but in time the railroads proved to be a faster, cheaper way of moving goods over the vast distances and eventually they replaced most of the inland, waterborne commercial transportation. The Erie Canal and the Mohawk Canal in New York are among the few that have survived and that operate in modern commerce, but the C&O Canal was overwhelmed by the competition from the Baltimore and Ohio Railroad and went out of business. Now that the C&O Canal is being restored as a National Historical Park, it will represent an example of living history in a national recreation area ideally situated for convenient access by large numbers of urban dwellers. The operation of the locks and the movement of barges on the Canal will provide a vivid demonstration of our national heritage as well as outdoor recreation in a national park for nearby residents and visitors.

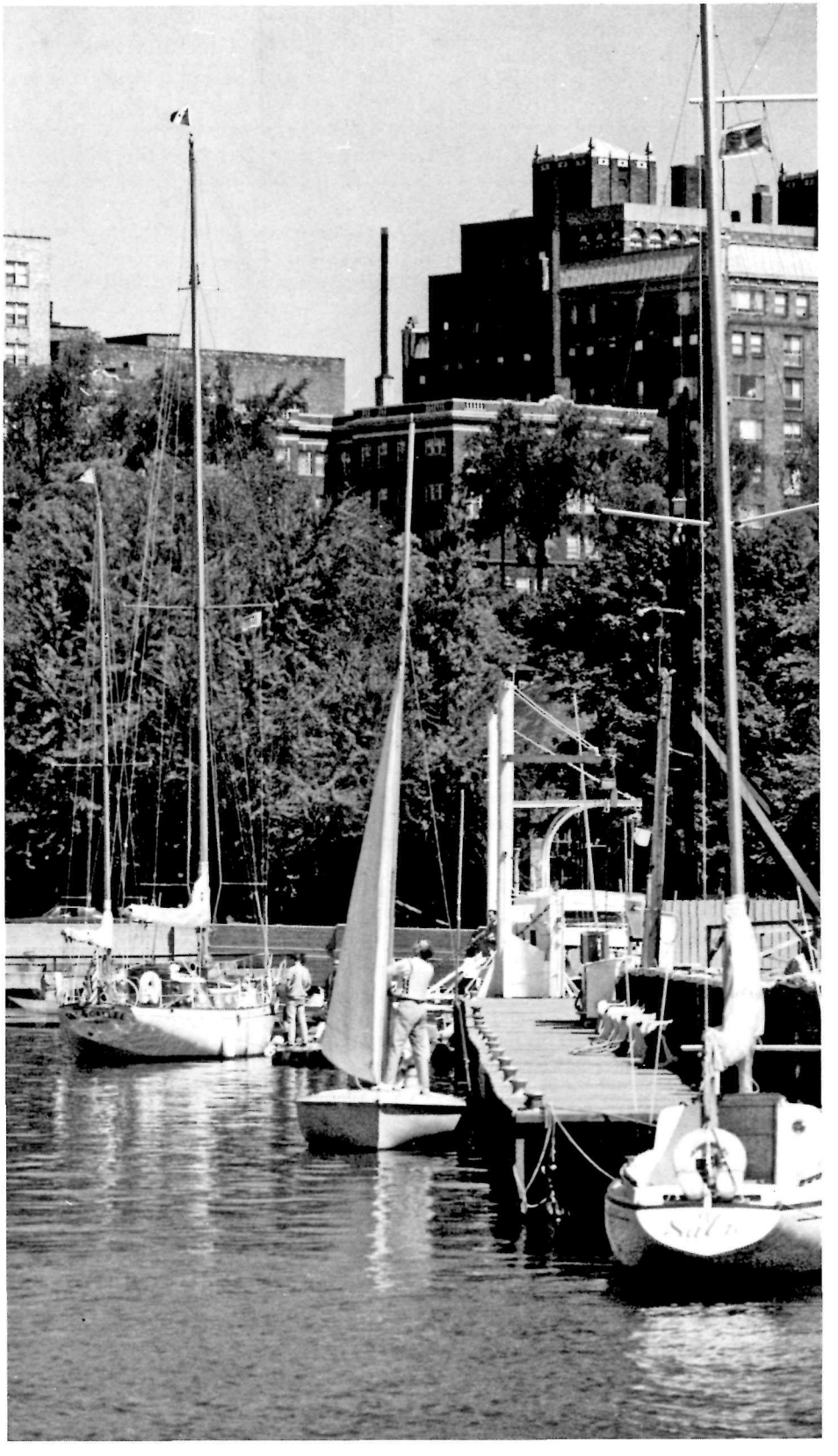
In an age of superhighways and jet planes, it is difficult to comprehend the enormous difference between the difficult and hazardous overland route through deciduous forests and the relative safety of the river system that brought the traveler to the same destination.

While the rivers functioned as the principal means of transportation, they also provided the basis for great adventures as Mark Twain's "Huckleberry Finn" testifies. In addition, the sternwheelers, the pleasure and excursion boats, and the showboats constituted a romantic and gallant way of life that many Americans look back on with nostalgia. With the advent of railroads, however, people shifted from water transportation to the new iron horse and, at the same time, the users of the rivers for industrial transportation and sewage disposal increased and brought about the decline of the river, a decline that with few exceptions continues to this day.

The Decline of the River

In the middle of the 18th century the United States was engaged in a large and lucrative fur trade with Europe, and most of the furs were found along the river systems of eastern North America, and later around the lakes and river systems of north central North America. The great canoe route from central Canada to Montreal traversed the lakes and some of the slow-moving rivers of southern Canada, proceeded via Lake Superior, the French, Mattawa, and Ottawa Rivers and finally to Montreal and the St. Lawrence River system, the gateway to Europe. By this route furs were carried in canoes and sailing vessels from the interior of the continent to Europe.

Beaver was an extremely important item in this fur trade, and on the Ohio River in western Pennsylvania a county that borders on the State of Ohio has place names that testify to the role that beaver played in the area. The county is, of course, Beaver County. The county seat is Beaver, Beaver Falls is one of the larger towns, and the Ohio River Valley, as it runs through the county, is known as the Beaver Valley. In addition there is Beaver Creek and the Beaver River. The disappearance of the beaver from Beaver Valley is symbolic and connected with man's technological development of the river systems, rising industrialization, and change in the priorities and values associated with the river systems. All of these factors altered the river systems biologically as well as

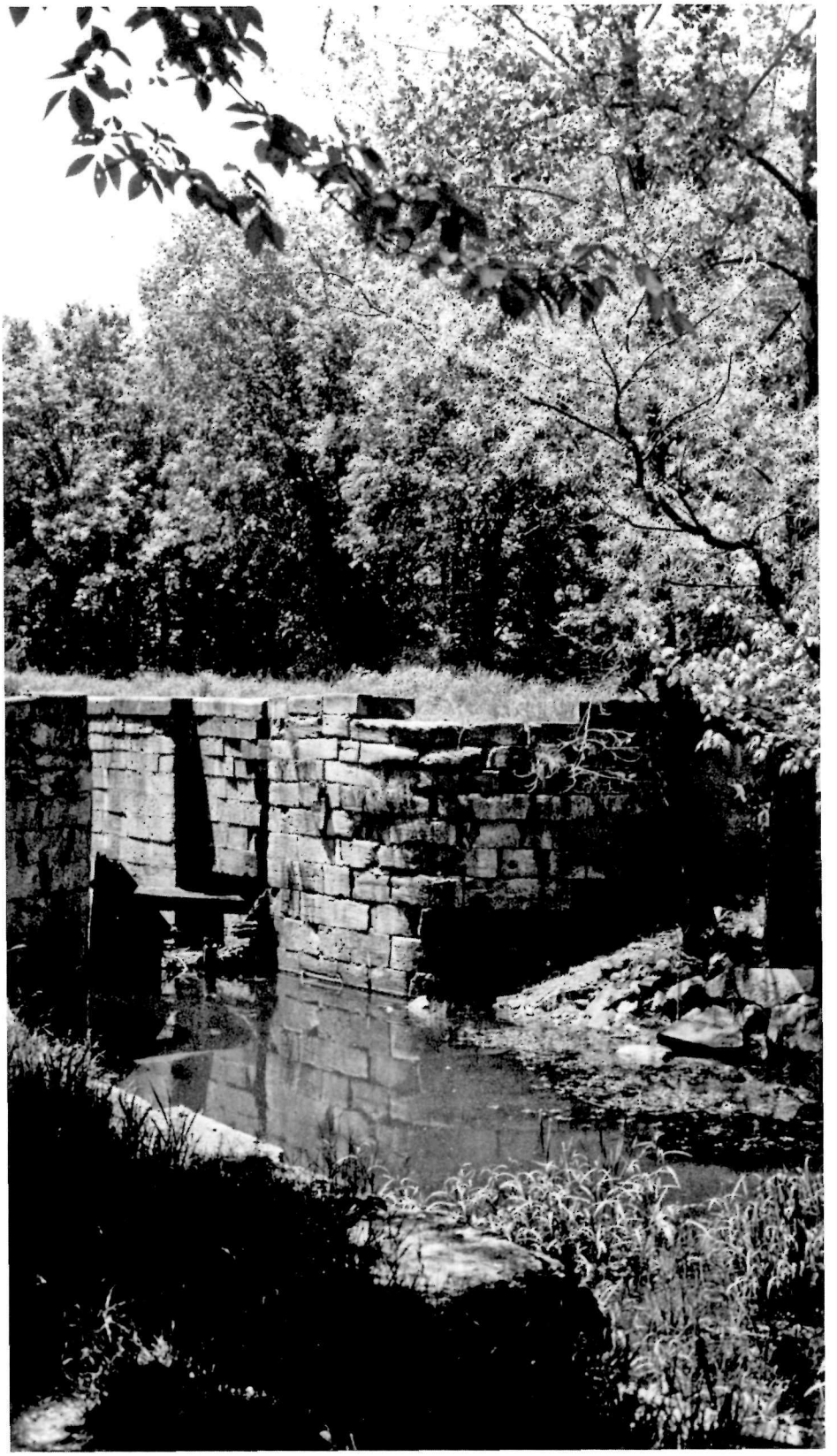


technologically and forced them to serve the needs and purposes of man. The flood plains have been occupied, the wetlands and marshes filled, the tributary streams channeled elsewhere, and the major river systems drained and dredged for flood control.

The installation of locks and dams on the river did two things: regulated the flow of water making it independent of the season of the year, and converted the flowing rivers into what were essentially a series of flat lakes with locks that permitted the movement of barges through the various levels.

Prior to the construction of locks and dams and other aids to navigation, traveling most rivers was a hazardous business. It required great skill to negotiate the rapids and similar obstacles and necessitated transfer points to go around the rapids. The Lower Mississippi, of course, still has no locks or dams to regulate its flow and from the point of view of river travel, it remains an extremely dangerous river. It has currents and eddies, it is wide and sweeps around bends at fairly high velocity, and it is prone to floods. The surface of the river is higher than the surrounding delta county, making floods a constant threat. On the Lower Mississippi, flood control is primarily a spin-off from the preventive flood control on the Upper Mississippi, the Ohio, and the Upper Missouri, although it should be noted that stabilized levees, paved river bottoms, overflow diversion channels and sluices, and hydraulic pumps on the Lower Mississippi represent an outstanding example of the engineered environment.

While the rivers made transportation, exploration, and commerce possible, they also served as a water supply, a source of bulk chemical water for industrial processes. Moreover, the river served as an open sewer for the industrial and municipal wastes that resulted from the industrialization itself and from the cities that developed around it.



It was a natural development that railroad rights-of-way followed the river valley. Such a procedure made for easier construction, for easier movement of materials to the construction site, and also eliminated the need for more bridges and trestles to accommodate the railroad rights-of-way across valleys. Along the Upper Mississippi, railroad rights-of-way occupy both banks and obstruct from view and use one of the most scenic rivers in the United States.

This must be viewed as an outmoded way of locating highspeed rail transportation. The interstate highway program has demonstrated that roads and bridges, and by extension, railroad tracks, can be built economically by taking the shortest distance between two points. Thought should be given to the possibility of opening up the shoreline of rivers for recreational development by rerouting some railroads and combining them with highways in common transportation corridors.

In a technological age this should not be an insurmountable task. Moreover, the relocation of railroads away from the river valleys might induce some heavy industry to follow this example and thus free additional land adjacent to rivers for alternative development.

The great cities that were built along rivers in order to take advantage of their transportation potential, their water supply, and as a means of disposal of wastes altered the character of the rivers from a wild, untamed state to floating garbage pails, rendering them unfit for human use and destroying wildlife habitat.

In the early days of exploration and expansion, there were sound reasons for locating cities on the coast at good harbors, at the confluence of rivers, or at other river locations where water power and water transportation were available. This is true of Boston on the Charles River; Minneapolis-St. Paul near the confluence of the Mississippi and Minnesota Rivers; and Philadelphia on the Schuykill and the Delaware. Springfield and Hartford are two cities strung like beads on the Connecticut River, while New York has the picturesque Hudson, the Harlem, and the East Rivers. The Ohio starts at Pittsburgh as the confluence of the Allegheny and the Monongahela Rivers and runs through the industrial heartland of Pennsylvania, West Virginia, Ohio, and Kentucky. In its first 50 miles the Ohio passes through McKees Rocks, Bellevue, Ben Avon, Avalon, Corapolis, Sewickley, Leetsdale, Ambridge, Aliquippa, Baden, Conway, Freedom, Monaca, Rochester, Beaver, Vanport, Midland, East Liverpool, Wellsville, Empire, Toronto, Winton, Steubenville, Mingo Junction, Follansbee, Brilliant, Wellsburg, and Wheeling. From West Virginia the Ohio River runs through Marietta, Parkersburg, Huntington, Portsmouth, Cincinnati, Covington, Lexington, Evansville, Paducah, and Cairo, at the confluence of the Ohio and the Mississippi.

Similar lists of towns could be made for the Mississippi-Missouri Rivers which drain the heart of the continent; the Platte of the high plains; the Potomac and Susquehanna flowing through the mid-Atlantic states to Chesapeake Bay; the Connecticut running south through New England; the Hudson River in New York; the Tallapoosa and the Coosa running through Alabama; and the Rio Grande in the Southwest, forming our common boundary with Mexico. All these rivers and many more were the transportation corridors of the developing continent and also the lifeblood and source of prosperity for the cities, towns, and villages that were established on the shores and at the confluences.

Industrial development in the United States followed the pattern of water power development and transportation facilities. The industrial development of New England, with its small factories located on streams that were essential to the water power in use in the late 18th and early 19th century, contrasts sharply with the large industrial developments that occurred further inland, but the principle is the same. Here steel mills and other heavy industry occupied vast flood plains and the rivers served as avenues of transportation for goods to the consumer and of coal to the coal-burning, steam-generating power plants that, in turn, supplied the electrical energy necessary to power the industries.

The Ohio, the Upper Mississippi, the Missouri, the Kanawa, the Chicago, and many other rivers were essential to the development of natural resources and to the manufacture of goods of every kind. As a result, they were regarded as convenient adjuncts to the industrialization process and the viability of the rivers as ecosystems was ignored.

When the rivers became the common method of sewage disposal as well as the main source of water supply for the cities located along their banks, chemical water treatment was a simple mechanical filtration through beds of sand, plus chlorine for bactericidal purposes. Those cities having more advanced water treatment facilities added the refinement of a water softener in the form of salts precipitation, and in this way the city's water supply was potable as well as acceptable as a cleaning agent. This procedure treated the water as a bulk chemical and the water inlets and outlets might, and often were, in close juxtaposition to each other in the river. The standard practice was to drill wells into the river bed and to filter the water through the sand beneath the bed. The water was river water, but some filtration had taken place. Modern water treatment plants often must cope not only with the public health problems of sewage but with heavy metals such as mercury, zinc, cadmium, and lead, with acid sulfate wastes, with nitrate from agricultural fertilizer runoff, with excessive phosphates, and with a host of pollutants from the manufacturing, extracting, and agricultural industries.

As a consequence of industrialization and the burgeoning population in our metropolitan areas coupled with the barest minimum in sewage treatment facilities, no major river in the United States has water that is fit to drink untreated today, and none is fit for body-contact water sports. It is hard to believe that the Chesapeake Bay, the Hudson River, and most of the Atlantic Coast once boasted salmon runs and that rivers such as the Ohio River were the habitat for pike, sturgeon, and bass. Furthermore, there was a time, difficult to imagine, when prized game fish and many of the most prized fur-bearing animals were common along the flood plains, wetlands, tributaries, and estuaries of the major river systems of the United States.

In 1970, the spring runoff from the frozen agricultural uplands of Maryland and Virginia dumped unusually large quantities of nitrogen compounds into the Potomac River. The water purifying equipment could not cope with the pollutant, and a foul-tasting water supply resulted. The beneficiaries were suppliers of bottled water whose stocks were quickly exhausted. A large number of people resorted to collecting and boiling rainwater for domestic use until the quality of the faucet water was restored. Sediment is the main problem created by agricultural runoff, and the many water impoundment facilities constructed in recent years have done much to alleviate the problem. There are now some 1000 dammed watersheds that trap much of the sediment but an equal number are still needed.

The Cuyahoga River in Ohio was created by the Wisconsin glaciation. It rises near Cleveland, a few miles from the shore of Lake Erie, runs southward through the town of Kent, Ohio, westward through Cuyahoga Falls, west and north through Akron, and finally back to Cleveland, where it enters Lake Erie about 30 miles from its source. At Kent, the river goes over a falls in the middle of town and

flows through a series of falls to the next town, Cuyahoga Falls, and finally into Cuyahoga Gorge, which is wild and scenic. The Cuyahoga River from Kent to Cuyahoga Falls, through Cuyahoga Gorge, qualifies as a wild scenic river by any standard. As the river goes through Akron, however, it becomes an outlet for industrial wastes, and as it flows through Cleveland it becomes an open sewer for heavy industry and for the city of Cleveland. This river, which is 60 or 70 miles long, is part pristine beauty and wilderness and part polluted sewer that not long ago actually caught fire!

It is ironic that New York City, one of the great cities of the world, traditionally suffers from a shortage of water, even though it is situated on the banks of the Hudson River, one of the greatest sources of freshwater on the eastern North American continent. Pollution makes it impossible to use the water from the Hudson as it flows through New York City and supplies must be brought from reservoirs miles up river to the metropolitan area.

Recreational Potential

When the great power projects were installed in the western United States, the impounded water was usually converted into a recreation area. Hoover Dam forming Lake Mead gave us the Lake Mead National Recreation Area, Glen Canyon Dam forming Lake Powell became the Glen Canyon National Recreation Area, and so on. Yet the great dams that were built on the Ohio River, Upper Mississippi River, and other navigable rivers of the eastern and central United States were not accompanied by official recognition of their recreational potential, even though they are the habitat of game fish and migratory birds, have interesting plant and animal communities, and could be as much a source of enjoyment for city residents as any body of water anywhere.

Moreover, these rivers are easily accessible to urban dwellers. New Yorkers have ready access to the East River, the Harlem, and the Hudson, as do Pittsburghers to the Ohio River, the Monongahela, and the Allegheny; Akronites to the Cuyahoga River; Bostonians to the Charles River; and any number of other cities located on large and small waterways. A group of New Yorkers recently made a 120-mile canoe trip on the waterways of New York and never lost sight of the city. True, they encountered a good many problems including oil slicks that fouled some of their equipment and pilfering at piers where they stopped along the way, but they proved that it is possible to take a 120-mile canoe trip without leaving the environs of New York City.

Most of the great rivers of the United States that run through large cities have flood control and navigational aids that make the rivers safe to use. In essence, these man-made alterations to the river create a series of oblong lakes with little current. If one drives from Pittsburgh south toward Steubenville, Ohio, Huntington, W.Va., and Cincinnati, Ohio, one is struck by the fact that the many cities, towns, and villages do not front on or look toward the river, but have turned their backs and left the river abandoned on the other side of the tracks.

The Ohio River is a peculiar one formed by the drainage of the glacier, and its walls are relatively steep, its flood plains relatively narrow, and in the cities, towns, and villages of the Ohio River Valley there are stretches of river bank that are wild and scenic, but little used. Until recently, the pollution and acid content of the Ohio made it virtually impossible to engage in any form of water sports, and to swim was to expose oneself to the dangers of waterborne diseases. In 1949, the seven states bordering the Ohio River entered into a compact to clean up the river and there has been considerable progress. The result is a revitalizing of the area with marinas and pleasure boats and the development of other services associated with the life of the river. But swimming and water contact sports are still not recommended.

But the Ohio effort notwithstanding, the waterways in most of our cities are wasted resources. A beautiful river runs through the resort town of Estes Park, Colorado, but it is not visible from the town. The city faces a main street, while the river runs through the back of the town, out of the way and encased in concrete. Engineering skills have made the river easy to cross but it cannot be used by residents or visitors. The exception is the tenant in a back room of one of the enterprising hotels that face the street and back onto the river. These advertise "Fishing

from your own back porch," and the fish are trout! The commercial potential of the river has not been developed as it could be if the shore were a city park, a place or people to meet, to stroll, and to enjoy, as well as to fish.

Such development has taken place on the Ohio River near Empire, Ohio. When the Cumberland lock and dam were installed, the river backed up into Yellow Creek, a little stream between Toronto and Wellesville, Ohio, deepening the creek and creating an environment favorable for a marina. So far, it remains inadequately developed, but it provides facilities for a number of boats and for a recreational area on the stretch of the Ohio River that is accessible to many people.

Excursion boats once operated between cities located on rivers and amusement parks at sites some distance up or down stream, such as Rock Spring Park near Chester, West Virginia. In Pittsburgh today an excursion boat carries passengers onto the Allegheny and Monongahela Rivers. The boat is a floating nightclub whose patrons can select from among several dance floors featuring different styles of music, and for the 3-hour trip they remain within sight of the city and can view its skyline from a new perspective. The University of Minnesota maintains a link with the past with a showboat that takes theatrical productions to river towns on the Upper Mississippi. The University acquired a river packet, the *General John Newton*, from the U.S. Army Corps of Engineers, rebuilt the superstructure in the form of a small theater, and launched its career as part of Minnesota's centennial celebration.

There is no doubt that a thriving recreation industry could be developed on most rivers of the United States, and such development would be most appropriate, not to say profitable, at places where the river runs through heavily populated areas. The impoundment of the rivers for flood control and for navigational purposes and the utilization of the rivers for municipal water supplies are in no way incompatible with the use of the rivers for recreation. This is not to suggest that all rivers should be impounded and made into lakes, for obviously many wild and scenic rivers should be preserved precisely as they now are.

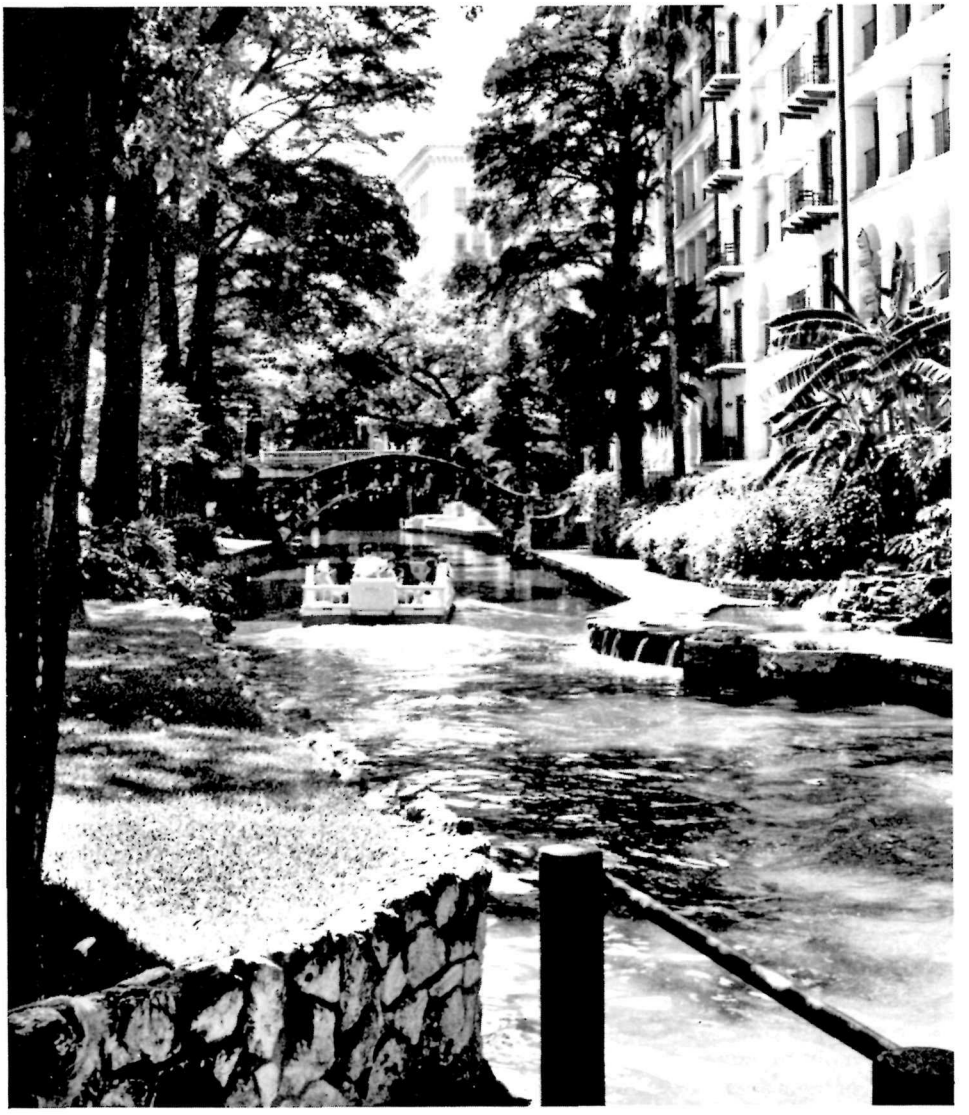
If the rivers in our cities were clean, if the water were potable, and if the water had its natural biological, physical, and chemical properties restored, how could they be used? Obviously, the rivers could be used for swimming, for fishing, and for water skiing, and they could be the starting point for hunting trips, for canoe rides, and for excursion boats and showboats. A few cities already have restaurants floating on barges in their rivers.

But much of the waterfront of many of our large cities is in a rundown industrial area. The city of Pittsburgh held an exposition in the 1880s and the exposition building sat on the bank of the Allegheny River until after World War II. In 1940, a visitor seeking the remains of Fort Pitt's blockhouse was directed to a hole in the ground that was a repository for tin cans and waste paper.

Today, Fort Pitt in the Triangle Park development demonstrates what a little civic pride can do. The old exposition building is gone too, but the possibilities for development of stretches of the Monongahela, the Allegheny, and the Ohio Rivers still escape the riverfront real estate developers and others interested in introducing new business into the area.

The City of San Antonio, Texas, agonized over the problem of the San Antonio River as it passes through the downtown section of the city, and proposals included covering it with a street as an aid to flood control and sewage disposal. Happily, the more rational views of civic leaders, businessmen, landowners, and real estate developers prevailed, and today the 3.5-mile stretch of river has gained national attention as the Paseo del Rio. It is a charming development of shops, restaurants, promenades, and parks that not only enhance the beauty of the city but also provide a recreational area for residents and visitors. Flood control, planning, zoning, business enterprise, and civic pride made it possible and it has become a model for urban development of waterfront property. The long-range plans for San Antonio include expansion of this concept on the river.

The number and kinds of activities that can be developed on a river recreational area are almost unlimited and will be the basis for a whole new industry centered around marinas, boats, sporting goods stores, restaurants, pleasure trips, and second-home sites. For those less energetically inclined, the rivers will once again provide excellent opportunities for observing nature and enjoying the scenery of the countryside. The recreational development of the rivers in the cities will require some precise and stringent regulations relating to sewage and solid waste disposal, as well as methods of enforcing such regulations. Some limitations of power boats and water skiing might have to be imposed, particularly at narrow stretches of the river, and regulations that would promote the harmonious intermingling of commercial and recreational traffic on the river would undoubtedly be required. In some areas, particularly at locks, appropriate regulations are in force and aids to navigation and law enforcement on the nation's waterways are provided by the U.S. Coast Guard.



It is interesting to speculate on recreational areas for cities and to consider that most of the large cities of the United States have many miles of riverfront and hundreds of acres of river. Much of this acreage is in public ownership and much of it is available for immediate use and could be developed for recreational purposes. The present practice of river use is based on single factor cost-benefit ratios, where the cost of cleaning up the river is balanced against costs that are related in terms of reducing costs of water treatment. If the sewage water could be cycled so that its nutrients were utilized for the benefit of the cities and the surrounding agricultural communities, what benefits would be derived? If the efficiency of industrial processes is considered, the cost-benefit ratio can be analyzed from the engineering as well as the environmental point of view. Significant quantities of valuable materials are dumped into our waterways and their recovery is extremely difficult, but these materials could be salvaged at the source with relative ease. The tons of acids from heavy industry that enter our rivers and the quantities of valuable elements that arrive via industrial sewers destabilize or destroy the aquatic ecosystem, deprive man of the use of the rivers except for transportation purposes, and may seriously affect the public's health. Viewed economically, what is the market price of one million pounds of sulfuric acid that is dumped into an eastern river daily? What would be the savings if the acid was recovered for further use? To what extent do these contaminants alter the cost-benefit ratio of river development?

If one figured the cost-benefit ratio of using the Cuyahoga River as an open sewer as against using it as a scenic recreational area, one might discover that the ratio is not overwhelmingly in favor of industry and an open sewer. Only when the cost-benefit ratio is calculated on single uses does the open sewer concept appear to have merit and only then because the river itself is deemed to have no value. For instance, the comparative cost between allowing industrial wastes to enter the river or building industrial water treatment plants is clearly in favor of the former. But if the cost of treating the municipal water supply—essential when the water is industrially polluted—the balance moves in the other direction. If the cost of illness and disease, the value of wildlife, and the value of hard cash-on-the-barrel recreational potential is included in the equation, the cost-benefit ratio tips further away from the use of the river as an industrial and municipal sewer.

When the interests of the total ecological community are ignored in favor of some of its components, the cost-benefit ratio for the despoilation of the environment is in favor of a single or several individual users. In the economics of the new environment it will be necessary to have an accounting sheet with more entries than the cost of industrial water treatment, the cost of sewage disposal, and the cost of municipal water treatment. Future balance sheets will have to include the myriad complex but accountable factors of fish and wildlife, game, recreational facilities, the purchase of boats, the servicing of boats, the building of resort communities, the building of second-homes, the increased demand for consumer goods, and the products of industry that are necessary in order for our economy to grow, as well as a beautiful environment that enhances the healthful life of man.

In short, if the rivers are restored to their best biological quality, it should be possible to devise cost-benefit ratios for the use of the rivers for many purposes. Under these circumstances, the value of the living rivers as recreational areas, for wildlife production, and for hunting, fishing, swimming, and other water sports will outweigh their single purpose value as

channels for industrial and municipal wastes. Clean rivers will serve the larger community and continue to serve the industrial community as transportation routes and sources of the bulk chemical, H_2O, providing that pollutants are removed before the effluent is returned to the river. The marvelous characteristic of water is that it can be reclaimed and reused and can serve all of the purposes of sustaining basic life processes and technology as well. For too long we have considered water a cheap, expendable bulk chemical that by some miracle would process and purify itself. Perhaps there was a time, when there were less pollutants and lower concentrations of biodegradable materials being pumped into the rivers, when natural processes could rectify the damage caused by man. But today, we have so altered the biota and the biological properties of the waterways that natural processes can no longer rectify man's abuses.

The river as an unexplored, undeveloped resource for city recreation is second to none in its potential, and yet we search for space in which to locate recreational facilities in the city while ignoring the most obvious. To develop city recreational facilities centered on the river is not to deny the merits of the wild scenic river. The scenic river as part of an unspoiled, untrammeled, unexploited area of the countryside should be preserved and developed for its own sake. The river in the city, however, can be as great a resource of delight as any lake or other body of water that people drive hundreds of miles to admire and to use.

Conclusion

The concept of restoring the nation's waterways to their natural chemical, biological, and physical integrity is a desirable goal, one that will return them to public use by reestablishing a condition fit for swimming and other water sports as well as for the propagation of fish, shellfish, and wildlife.

Until this has been accomplished, the development of boats with hulls of plastic or other pollution-resistant material has made it possible to use many waterways for boating. In the 1920s and 1930s when industrial pollution was at an all-time high, it was virtually impossible to put a pleasure boat into the water without it dissolving, but today pleasure boats can be seen on many rivers and marinas are springing up along their banks.

In the western United States, particularly in desert regions, there is a different attitude toward rivers from that found among Easterners. Water is such a scarce commodity in the West that vast quantities such as Lake Mead and Lake Powell are euphoric in these very arid areas, and the irrigation waters out of the Snake River, the Gila River, the Salt River, and the Rio Grande give these rivers a special significance in the agricultural development of the region. The All-American Canal that carries water from the Colorado River to the Imperial Valley of California serves a multimillion dollar agriculture enterprise and makes the desert bloom as never before possible. This aspect of rivers and canals is quite different from the view of the river as a means of transportation, for irrigation rights make the difference between successful farming and no farming at all.

The great man-made bikes, notably Powell and Mead, probably serve the same people for recreational facilities as are served by the power generated there, but since the rivers in the east and central United States were developed with the industrial cost-benefit concept paramount, the recreational potential of these areas was largely ignored in favor of a near-exclusive use by industry.

Twenty-four cities in the United States have over one million population and almost all of them are located on rivers. San Antonio has shown the way with river and waterfront development for recreational purposes. In sharp contrast, many cities have turned their backs on the river. St. Louis, the gateway for the westward expansion, has a great arch commemorating its role in history. But as paradoxical as it may seem, this overwhelming fact could not be deduced from the St. Louis waterfront.

The Connecticut River has been relegated to a role of sewage disposal. Most of this beautiful river is undeveloped and should remain so. Where it traverses the many cities from Vermont to Long Island Sound that are in its path, it could provide recreation for millions of urban dwellers and focal points of man-nature interaction—demonstrations of man in harmony with the environment rather than destabilizing the environment as a result of using the river as a sewer. The majestic Hudson is the epitome of river desecration on the North American continent. Recent curtailments of the absolute amount of sewage and industrial effluent, however, have given hope of recovery, and the activities of the sloop *Clearwater* have dramatized the plight of this great waterway. This magnificent replica of a river sloop from the past has given many school children the opportunity to know the thrill of moving under sail, and it symbolizes what the Hudson and other rivers can and should be: a clean river with clean water; water to drink and swim in; water that supports the life of the river and the birds and reptiles and the furbearing animals along its shores; water that forms the basis for life—all life on earth.

That a river could actually burn as the Cuyahoga did is a manifestation of the influence of technology, industrialization, and the building of cities on the waterways. Industrial man must extend his vision beyond the paramount need for machines and technology that rapaciously consume diminishing resources and must recognize that industry is an ecological flywheel capable of supplying energy and commodities while restoring the environment of the river for the use and pleasure of all people. The rivers are everywhere and so are the people, and no resource would be more easily developed for the enjoyment of urban communities than the rivers in their midst.