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Bulletin No. 17: Preserving Our Freshwater Wetlands

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BULLETIN NO. 17

PRESERVING OUR FRESHWATER WETLANDS



CONNECTICUT ARBORETUM
CONNECTICUT COLLEGE
NEW LONDON, CONN.

PHOTOS

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THE CONNECTICUT ARBORETUM

BULLETIN NO. 17

JUNE 1970

CONTENTS

FOREWORD — <i>William A. Niering</i>	3
TODAY'S CHALLENGE: INLAND WETLANDS	4
THE VALUE OF WETLANDS TO MODERN SOCIETY — <i>U.S. Dept. of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife</i>	6
THE ECOLOGY OF WETLANDS IN URBAN AREAS — <i>William A. Niering</i>	12
IN DEFENSE OF MUD — <i>Edward S. Deevey, Jr.</i>	20
THE BANTAM RIVER	27
SOME LEGAL ASPECTS OF PRIVATE ACTION IN THE ESTABLISHMENT OF NATURAL AREAS IN THE UNITED STATES — <i>Richard H. Goodwin</i>	32
FOR THE MUNICIPALITY, A WETLANDS ORDINANCE.....	45

Betty F. Thomson, *Editor*

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THE CONNECTICUT ARBORETUM ASSOCIATION

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Checks should be made payable to the Connecticut Arboretum and sent to the Director, Dr. William A. Niering, Connecticut College, New London, Conn. 06320.

SOME DEFINITIONS

Wetland: Any area that is more or less regularly wet or flooded, where the water table stands at or above the land surface for at least part of the year. These are distinguished according to the condition of wetness and the resulting type of vegetation into marsh, swamp and bog.

Marsh: An area normally covered with shallow water the year round. Typical marsh vegetation is rooted in the underwater soil and may be totally submerged, float at the surface, or emerge above the water. Characteristic marsh plants are water lilies, pond weeds, cattails, sedges, arrowhead, and marsh marigold.

Swamp: An area that is flooded or water-logged in winter and early spring, but usually dry at the surface in summer. Ordinarily it is covered with wet-tolerant trees and shrubs. Typical are red maple, black gum or tupelo, willow, alder, sweet pepperbush, and highbush blueberry.

Bog: This develops in an essentially undrained depression with no outlet or where outflow is drastically impeded. Normal decay is extremely slow, and dead organic matter accumulates as peat. The water is cold, strongly acid, and practically devoid of oxygen and available nitrogen. Bogs harbor a distinctive group of plants that includes many members of the heath family such as cranberry, leatherleaf, and Labrador tea, as well as the insectivorous pitcher plant and sundew. Typical trees of northern bogs are tamarack and black spruce, while southern white cedar is most common in southern bogs. Also typical is sphagnum or bog moss that forms a thick, spongy, water-holding mass in which other plants may find a root-hold.

Floodplain: A flat, lowlying area bordering a river or stream; not strictly a wetland, since it is flooded only at times of very high water. All rivers flood periodically, however. In fact, it is the silt deposited during flood stages through the centuries and millennia of which the flood plain is constructed. One can expect that floodplains will continue to be flooded at intervals, a fact that should be considered in deciding how they are to be used.

FOREWORD

A decade ago *Connecticut's Coastal Marshes, A Vanishing Resource* appeared as an Arboretum bulletin highlighting the value of tidal marshes and the need for their preservation. Several reprintings were required to meet the demand for this publication. In 1969 legislation was enacted in Connecticut that was designed to give permanent protection to the state's salt marshes. We would like to think that Bulletin No. 12 played a catalytic role in bringing about this action.

However, another important set of wetlands, the fresh water marshes, swamps, and bogs that serve as built-in water storage and flood control areas, are also in need of immediate protection. Housing and commercial developments, highways, drainage for agriculture, and the use of these natural features as sinks for the disposal of solid waste continue to produce a staggering attrition of these liquid assets. Of the 127 million acres of freshwater wetland once found in the United States, less than 75 million acres remain, and these are disappearing at the rate of one per cent per year.

In this bulletin we have assembled a series of articles to document the value of wetlands and to describe methods that may be used to preserve them. Their values to the nation are forcefully reviewed by the Fish and Wildlife Service of the Department of the Interior. Dr. Deevey brings to light a heretofore overlooked role that wetlands serve in the release of oxygen through microbial activity. The role private citizens can play in preserving wetlands and the legal tools available to them are broadly covered by Dr. Goodwin. Also included is a case history of a group of local citizens who, by uniting their efforts, were able to preserve a flood plain landscape in a beautiful old New England Town. The easement which they developed provides an ingenious technique that may be applied to the preservation of open space of various kinds. For thousands of towns across our nation struggling to protect their wetlands, a model ordinance is included as still another approach.

Immediate action is still needed at the Federal level to formulate a national wetland policy. Such a policy would give national recognition to the importance of these resources and thereby aid and encourage states and towns to work more forcefully toward protecting them.

It is hoped that this bulletin may serve to focus public attention on these productive ecosystems and result in the preservation of this unique natural heritage.

William A. Mering
Director

TODAY'S CHALLENGE: INLAND WETLANDS*

You can't overestimate the importance of inland wetlands—of bogs, marshes, swamps, and river meadows. They tame floods, keep rivers flowing in midsummer, restore water to underground reservoirs, and hold the water table where it should be.

The water in your faucet probably seeped through a swamp before it reached your town or private water supply. If the swamp is drained and surfaced with asphalt, the water is more likely to flood your cellar.

If a town upstream locates a dump in a marsh bordering the stream you share, *your* water may taste of iron for the next decade. And if it permits a sand and gravel company to excavate in the flood plain, *your* wells may run dry.

How Wetlands Work

Bogs, marshes and swamps—giant sponges made of muck and specialized plants which can absorb up to 16 or 18 times their weight in water—soak up water fast and release it slowly. The soaking-up helps prevent flash floods downstream. The slow release gives some of the stored water time to sink deep into the ground where it replenishes ground-water supplies, keeps springs bubbling, and fills wells.

Downstream the work of marshes and swamps is supplemented by the wide, wet meadows of the river's flood plain, carved out by recurring floods long before the Pilgrims thought of leaving England. Although flood plains are not as spongy as the other wetlands, they hold and store water more efficiently than cultivated fields or even woods.

Some Consequences of Destroying Wetlands

When marshes and swamps have been drained, filled and paved, the water they would have absorbed in their natural state rushed downhill over the surface of the earth. This is runoff, and much of it is wasted water—lost to reservoirs, lost to agriculture, useless to industry.

Excess runoff upstream means floods downstream. If the flood plain has not been tampered with, the flood waters will be slowed down and contained. But if the river's right of way has been built upon, the flood rampages on across the flood plain doing high-cost damage to roads, houses, factories, utilities as it races to the ocean.

There is no substitute for natural wetlands in flood control and protection of water resources. In the last 30 years the U.S. Army Corps of Engineers has spent more than four billion dollars on flood control

*Reprinted from EARTH DAY HANDBOOK, published by the Connecticut Conservation Association, Mystic, Connecticut, 1970

projects. And in the same period the average yearly damage from floods (in terms of the 1960 dollar) has jumped from \$200 million in 1936 to \$700 million at present. Northern Italy is a well-drained and deforested country where hydroelectric dams instead of natural wetlands provide flood control. The dam whose overflow caused such destruction in Florence recently was located eight hours upstream, as flood waters rage, from the city itself.

As for water resources, in water-rich New England the water level of Quabbin, the largest reservoir, is so low that it will take 17 years of average rainfall for it to climb back to normal.

How Wetlands Can be Protected

Landowners in some communities such as Concord, Lincoln, and Wayland have taken voluntary action by putting restrictions on the development of their wetlands in the deeds to their property. The restrictions apply not only to the present owners but also to future purchasers, and are accepted as filling the legal requirements by the state's Department of Natural Resources.

Local zoning is another effective protection. Even the Army Corps of Engineers now recommends flood-plain zoning for parts of the Sudbury River instead of the construction of more dams.

Land acquisition by towns and cities can change flood plains from liabilities to assets. Milwaukee began acquiring land along the flood plains of its rivers some years ago and will soon have almost 5000 acres of flood-plain parks and recreation areas. When floods come, the damage will be trifling. In Cincinnati buildings have been torn down and replaced with parks and other useful open places that water cannot damage.

And the states themselves can act. A New Hampshire law protects the wetlands bordering lakes; when a developer flouted it at Squam, he was brought to court and lost the case. And in Massachusetts the Hatch Act theoretically covers *all* inland wetlands, but has no teeth. So neither law is ideal but both are promising starts on a big problem and both indicate New England's awareness of the importance of action at the state level.

THE VALUE OF WETLANDS TO MODERN SOCIETY*

U. S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife

Wetlands, for the purposes of this discussion, are defined as lowlands covered with shallow and sometimes temporary or intermittent waters. They include the areas commonly referred to as marshes, swamps, bogs, potholes, wet meadows, and river overflow lands. Shallow lakes and ponds, usually with emergent vegetation as a conspicuous feature, also are included, but the more permanent waters of streams, reservoirs, and deep lakes are not. Neither are water areas that are so temporary as to have little effect on the development of moist-soil vegetation.

Recreational Values

Some of the values which wetlands have for modern society are tangible and can be expressed in economic terms; others are entirely intangible. Between these extremes are many indirect contributions, tangible in nature, but difficult to evaluate on a monetary basis. Often, both tangible and intangible values are present.

By way of illustration, let us consider the wetlands of the United States. These wetlands are of particular importance because of the commercial and recreational value of the wildlife and fish resources they support.

Here, as in other countries, wetlands constitute the principal habitat for producing the annual crop of wild furs. The commercial value of this crop has declined markedly in recent years. Nevertheless, in 1960, the latest year for which data are available, the value of this crop amounted to \$10.5 million for mink, muskrat, otter, beaver, and nutria—the five species of fur animals most closely identified with wetlands habitat. This value could be increased considerably if fashion again made furs a popular item of wear.

Hunting is one of the major forms of outdoor recreation for North Americans and has important economic aspects. In 1960 the United States had more than 14½ million hunters. The amount spent during that year by the average hunter in pursuit of his sport was \$79, making a total of more than \$1 billion spent by United States hunters. A substantial proportion of

* Reprinted by permission from Proceedings of the MAR Conference, November 12-16, 1962. IUCN Publications new series No. 3.



"Many waterfowl species depend on small wetlands for at least a part of their lives. . . . There they nest on small, often temporary, wetlands ranging in size from fractional-acre puddles up to 100 acres or more."

the wildlife species taken by these hunters utilized wetlands as part of their habitat. Our nearly 2 million licensed waterfowl hunters with average expenditures of about \$46 per man, while waterfowl hunting accounted for \$89 million of the total hunter expenditures.

These figures tell only part of the story. There is probably a much larger group of persons who derive recreation from wild animals by observing or photographing them, or perhaps just by hearing their calls.

These are the so-called intangible values which also make up an unmeasurable part of the hunter's recreation. The \$89 million spent in harvesting waterfowl by American hunters thus represents only a small fraction of the over-all value of waterfowl to hunters or to society as a whole.

The evaluation of wetlands for waterfowl is further complicated by the behavior of the birds themselves. Many waterfowl species depend on small wetlands for at least a part of their lives. Consequently we should not overemphasize the large marshlands, dramatically populated by migratory birds, to the exclusion of the relatively small water areas that form an essential part of the seasonal habitat of these same birds.

The dollar values mentioned are realized for the most part on the larger marshes where most hunting and recreational use occur. Yet nearly two-thirds of the waterfowl of the North American Continent are raised in the glaciated prairies of north-central United States and south-central Canada. There they nest on small, often temporary, wetlands ranging in size from fractional-acre puddles up to 100 acres or more. Individually,

few of these ponds and marshes are spectacular, or by themselves would be assigned an over-riding high value for waterfowl or other wildlife. Collectively, they are the key to high productivity for most species of ducks of interest to the hunter. For upland game they also provide winter cover not otherwise naturally available on prairie range.

During its nesting season the black duck, the most important game duck of the Northeastern United States, is thinly distributed in wetland habitats throughout eastern North America. Individually of low productivity, innumerable small areas in the aggregate provide American duck hunters with a shootable population of black ducks each year. Thus, many remote wetland habitats seldom seen by man contribute importantly to modern society through production of valuable migratory birds.

Perhaps the greatest economic values of wetlands are in the field of marine fishery resources. Although detailed studies have only recently been undertaken, it is becoming apparent that many commercial marine species, such as menhaden and shrimp, spend critical portions of their life cycles in estuarine and other coastal marshes. Other species, such as oysters and clams, provide valuable harvests within the estuarine waters themselves.

The sport-fishing values of wetlands are difficult to assess. Although most of the important species of sport fish spend much of their time in waters too deep to be considered as wetlands, we know that the fluctuating margins, or wetland portions, of these more permanent water bodies make an important contribution to biological productivity and spawning. In some areas this has been recognized as of such importance that State legislation has been passed to preserve such marshes bordering fresh-water lakes for northern pike (*Esox*) spawning.

Not all of the economic return from wetlands is derived from the fish and wildlife they support. Under natural conditions, many marshes and other wetlands produce plant material having special properties that may find a ready market. Others, under limited management, may yield specialized crops of considerable value. The annual crop of wild rice harvested from wetlands in the State of Minnesota, for example, has been valued at \$1 million. Experiments in the neighboring State of Wisconsin indicate that several hundred thousand additional acres of wetlands in north central United States could be adapted to produce wild rice crops valued at \$90 per acre, exclusive of secondary revenues from fur animal or minnow production. The tubers of the broadleaf arrowhead (*Sagittaria latifolia*) are also harvested in considerable quantities along the Upper Mississippi River for use in the American Chinese food trade.

Other plant products of natural wetlands having economic value include the wild hay which is traditionally harvested in various sections of the country from both coastal and inland marshes. It is of special value to the farmer during drought periods when tame hay crops are unsuccessful. Hay

from coastal marshes is often used as mulch because it is relatively free of weed seeds. Its value is as high as \$30 or more per ton. Sometimes fibrous plants harvested from marshes have local values as raw material for chair caning, cask calking, and fabrication of mats and baskets.

The grass and grasslike plants in marshes also provide a source of pasturage for domestic stock. Grazing need not be harmful to the marsh environment if it is controlled. Often it provides openings on otherwise uniform stands of vegetation and thereby attracts a greater variety of wildlife than was present originally.

Wetlands of all types have a high intrinsic value for education and research purposes because of the great number and variety of life forms they support. The biological, intimate associations of plant and animal communities present in marshes and swamps represent an important resource for teaching and study. They are especially valuable to the researcher interested in tracing the intricate relationships of plant and animals under an ever-changing environment.

Many plants and animals exist only in wetlands. They often are of unique structure and adaptation. Preservation of such life forms is justified morally and esthetically, as well as scientifically, and requires maintenance of adequate tracts of the wetland environments in which they exist.

Water Conservation

One of the arguments frequently advanced for the preservation of wetlands is based on the possible relation between surface waters and underground water storage and streamflow. Statements have often been made that wetlands contribute to the reduction of peak streamflows, thereby preventing or limiting downstream floods. It is also claimed that they serve to recharge underground aquifers. On the other hand, in justification of converting wetlands to croplands, it is sometimes reported that drainage does not contribute significantly to downstream floods, and does not affect underground storage.

Some inferences regarding the possible effect of natural wetlands and downstream flooding may be drawn from the demonstrated success of small impoundments in retarding floodwaters and preventing floods. Many hundreds of such small floodwater detention reservoirs have been constructed during the past five years in the United States under federally assisted programs of water-shed improvement. It seems obvious that in many instances natural wetlands similarly located in headwater areas would aid in retarding floodwaters and preventing downstream floods.

In one specific study involving the headwaters section of the Ipswich River basin above South Middleton, Massachusetts, the U.S. Geological Survey found that marshes and swamps functioned both as water storage and as discharge areas and also occasionally as ground water recharge areas. Our present knowledge of these relationships is not extensive enough to justify generalizing on either side of this question. It seems logical that the

role of wetlands in water conservation will vary greatly with the underlying geologic structure and other characteristics of the individual site. Many more studies must be made utilizing modern techniques before final answers will be available.

Competing Interests

Agriculturalists in the United States generally take a very positive stand with respect to wetlands, such as swamps and marshes, that occur on farmlands. Many regard such wetlands as undesirable, because these areas represent water on potential cropland in sufficient quantity to interfere with crop production. Even where no potential for crop production exists, wetlands add considerable expense to farming with costly heavy machinery. Wherever crops are grown, therefore, there is a substantial economic incentive either to drain off excess water through tile or open ditch systems or to fill the wetland by grading.

In some situations, notably in the salt marshes of the Atlantic and Gulf coasts of the United States from New Jersey to Texas, certain wetland soils have been found to be wholly unsuited to agricultural use when drained. These soils, known as cat clays, contain polysulfides, which upon drying form ferric sulfates and sulfuric acid. Thus, when drained, such soils become for all practical purposes irreversibly acid, sometimes to a pH value of 2.5 or lower. Repeated refloodings on an experimental basis have not improved this condition materially.

There is now general agreement that the cat clay-soil areas in the United States are best left for wildlife use. Where naturally flooded or where a high water table is maintained, they are productive of waterfowl food plants varying from wild millets (*Echinochloa*) on moist soils to widgeongrass (*Ruppia maritima*) which flourishes under conditions of natural inundation or impoundment. Coastal impoundments can provide further benefits in the form of production of commercial shrimp, oysters, and mullet, as well as control of important salt-marsh mosquito pests as *Aedes sollicitans* and *A. taeniorhynchus*.

There are also instances where drainage of inland soils has resulted in considerable losses of wetlands with doubtful gains to agriculture. In one area in Minnesota, 98 lakes were drained in 1928, and subsequent studies indicate that less than half of the area of these lakes has been put to agricultural use. With increasing experience and study, agriculturalists in the United States are now undertaking few projects which do not result in economic gain.

Other important forces operating to destroy wetlands in the United States include industrial and real estate developments; construction of highways, parking areas, airports, and marinas; and ditching for control of mosquitoes. As with agriculture, the economic benefits to the individual or to a group of users will, with few exceptions, be found to outweigh the economic value of the individual wetlands in their natural state. An acre of

wetland with an economic value of only a few hundred dollars in its natural state may be valued at several thousand dollars for a private real estate development which destroys the wetland, and may be of only limited benefit to the public at large. Some of our foremost authorities in land and water use and recreational resource planning have recognized this situation and are beginning to seek a solution.

Public Interest in Natural Features

Our citizens, in a modern society, individually still place great value in what have been called the "natural amenities"—that is, the facilities for good living provided by clean streams well stocked with fish, attractively wooded lakes and ponds, unique plants and animal communities, and the restful open spaces which wetlands in their natural state contribute to any landscape. Our people have demonstrated a willingness to travel considerable distances to enjoy these natural features when they are no longer available near home. Also, on occasion, they have acted to preserve the natural amenities within certain local areas. Thus, a new force is emerging which will help shape the ultimate pattern of our land and water use. Still ahead of us is the stage where our society will decide the sort of gross environment it wishes to live in, and will refuse to condone decisions to destroy wetlands or other natural features, for economic reasons alone. We may find that the intangible values of these areas are worth more to society than any economic values they may have for private or industrial use.

In summary, in our present stage of development, one of the foremost problems in the preservation of wetlands in their natural state is the mechanics of evaluation. So far, we do not have a satisfactory method for measuring and comparing tangible and intangible benefits to society. Either we need to develop better techniques for expressing the value of these amenities in economic terms, or we must find some more equitable method for weighing their intangible benefits to society against the economic benefits to be derived from the various developments which result in their destruction. The latter alternative appears to be the most promising.

THE ECOLOGY OF WETLANDS IN URBAN AREAS*

William A. Niering

Man is a threatened species. The twin specters facing him are over-population and unbridled technology—both self-induced. The double threat is aimed most directly at man's environment. As the United States strives to accommodate more human beings than it has ever had to serve before, increased demands are placed on our natural resource bank. Our surroundings become increasingly crowded, noisy, and spoiled.

These opening statements from the 1968 Department of the Interior Conservation Yearbook No. 4, *Man . . . An Endangered Species?*, echo the grave concern being expressed by certain federal agencies and congressmen in Washington. As a nation we have in the 20th century reached a high level of affluence but the environmental price of this progress has been high. Accelerated eutrophication of our lakes and rivers so polluted they occasionally catch fire have prompted the enactment of federal water-pollution control legislation. But our rapid stride to opulence has also had a drastic impact on other natural landscapes, namely the wetlands. Although the nation's marshes, swamps, and bogs are among the most productive landscapes in the world these liquid assets have suffered greater destruction and abuse than any other natural habitat manipulated by man. As a result of draining, dredging, filling and/or pollution we have in the coterminous United States reduced the nation's wetland asset to 70 million acres, slightly more than half the original acreage (estimated 127 million acres). And the destruction is continuing at an accelerated pace of 1 per cent or more per year, favored by the pseudo-socio-economic concept that conversion of these habitats into other land-use patterns results in the highest and best use. Unfortunately, such decisions have usually been conceived in narrow economic terms with no critical evaluation of the significant ecological role in which such areas serve the community, the state, or the national interest.

It is in this context that I should like to examine the ecological role of our wetlands, the impact of man on their ecology, and the action which must be taken to safeguard these assets.

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"The nation's marshes, swamps, and bogs are among the most productive landscapes in the world."

The Ecological Role of Wetlands

In the urban-suburban complex the remaining wetlands are engulfed by some 140 million Americans crowded onto less than 5 per cent of the land. Yet cattail marshes, wooded swamps and fringing tidal marshes can still persist if given adequate protection from the environmental stresses of urbanization. Unfortunately, to the average urban dweller such areas appear to have little relevance to daily life. For this reason a preview of the ecological role these wetlands serve may be enlightening.

Hydrologic. Wetlands are of major importance in the nation's hydrologic regime. Because of their water-holding capacity they act as storage basins, assisting to minimize erosion and serving to reduce the destruction of floods. In cities this is especially important since urbanization intensifies the rate of runoff as buildings, concrete and asphalt tend to concentrate large volumes of precipitation. Cities being deficient in soak-in areas, the runoff is usually rapid and in excessive volumes. Wetlands, including flood plains, act as catchment basins and tend to slow the speed of flow, thus minimizing flood damage. In 1955 when the severe floods struck eastern Pennsylvania hundreds of bridges were washed out along the stream courses. However, two bridges of the type destroyed were left standing below the Cranberry Bog, a natural area preserved by the Nature Conservancy. Flood plains also represent a hydrologic feature ideally designed to carry water during peak flows. Every effort should be made to maintain these valley landscapes free of developments; they should be

restricted for recreation or for those activities not incompatible with periodic flooding.

Furthermore, wetlands are important oxidation and sedimentation basins where tons of organic and inorganic sediments are deposited from the urban runoff. Although the organic component accelerates eutrophication when intercepted by marshes and swamps, it is slowly oxidized and the nutrients made available to the wetlands ecosystems rather than being flushed into rivers and streams or the local sewage system.

Marine Productivity. We turn now to the coastal wetlands. Tidal marshes represent an important marine resource that is rapidly being engulfed by development. Extremely limited in extent, these fringing wetlands are delicately balanced ecosystems that grow upward and landward, keeping pace with the constantly rising sea level. Although most of the rise was completed 5,000 years ago, it is still occurring at the rate of about three inches per century along the Atlantic shoreline. In response to a complex of factors involving salinity, there have also developed distinctive belts of marsh vegetation that progress from the estuary to the upper marsh border. There is not only a tendency for sediments to accumulate but also for nutrients to concentrate at the break in the slope and at the tidal-freshwater interface. Therefore, the marsh-estuarine system is one of the most productive in the world. It has been reported that seven times more protein is produced in a Georgia saltmarsh than in the best Kansas wheat field. In the marshes begins the food web that supports our coastal fisheries. Algae and detritus from the marsh grasses nourish the shellfish. The abundance of plankton and crustaceans provides food for small fish such as menhaden, which are consumed by flounder, striped bass, and bluefish. These in turn support our spectacular gamefish—tuna, marlin, swordfish, and sailfish. Here too are the nursery grounds for two dozen or more commercially important crustaceans, shellfish, and finfish. In fact, it is estimated that 90 per cent of the total harvest of seafood taken by American fishermen is caught on the Continental shelf, and that about two-thirds of these species are dependent in part on the marsh-estuarine ecosystem.

Tidal marshes are geologically significant as sediment accretors. When the marshes are destroyed those sediments that are normally deposited on the marsh in its upward growth accumulate in channels; the channels must be constantly dredged of the deposits. The organic carpets of peat and marsh grasses in tidal marshes exhibit great resiliency and buffer the shoreline during periodic storms, giving the upland an added degree of protection.

Duck Breeding Areas. Although the nation's midwest pothole country produces over 50 per cent of our ducks, the eastern coastal marshes around suburbia produce 200,000 and the southern states another 700,000 during the best years. Even though those in the west are most

significant as breeding areas, all are important, including those in and around cities that serve as vital resting and feeding grounds during migration. New York's Jamaica Bay is an excellent example. We should also recognize that the condition of wetlands which serve as breeding grounds for a migrating resource affect the waterfowl population and ultimately the hunter or naturalist thousands of miles away.

Education and Recreation. Wetlands are outdoor educational and scientific laboratories. They furnish the resources for scientific research and serve as living museums for teaching the dynamics and ecological role these systems serve. At the Connecticut Arboretum the permanently preserved wetlands have been variously explored by Connecticut College students. A red-maple swamp, actually a bog, with its underlying twenty feet of peat was a challenging problem to an undergraduate student as she unravelled the 13,000 years of post-glacial forest history revealed by the pollen preserved in the peat. The Mamacoke tidal-marsh salinities studies have been conducted in an effort to let us better understand marsh zonation, and permanent mapping studies will reveal future changes in the marsh vegetation. At the Thames Science Center, closely affiliated with the Connecticut Arboretum, thousands of school children annually are given first-hand field experience and are being taught the value of wetlands. The Arboretum Guided Tour used by the teachers makes its point about the wetland along the route: "The swamp below this dam is roughly an acre in size. If flooded to a depth of one foot it would hold 330,000 gallons of water. Thus whenever a swamp is filled or drained another large quantity of water is lost from the underground water supply and made to run off more quickly to aggravate flooding problems downstream."

Wetlands also provide many recreational outlets such as fishing, hunting, bird watching, or hiking. Twenty million Americans go fishing, two million hunt waterfowl. Thousands hunt with binoculars and cameras where an unparalleled diversity of waterfowl and spectacular marsh birds gives pleasure and inspiration. On Staten Island a unique fenway system has been proposed for incorporating the wetlands as part of the open-space pattern. It represents a sound ecological use of resources and the recreation potential is unlimited. Such a mosaic of open space serves as an essential structure to any developing community. It serves an important social function and greatly enhances the quality of the environment.

The Impact of Man

In *The Merchant of Venice* Shakespeare wrote, "... You take my life when you take the means whereby I live."

Filling, Dredging, and Draining. Wetland destruction as a result of filling, dredging, and draining has been widespread, especially in highly developed areas. Tidal marshes on the south shore of Long Island Sound

have been reduced from 30,000 to 16,000 acres. Similarly along the Connecticut shoreline almost half (45 per cent) of the 36.5 square miles of salt marshes found in the state in 1914 had been destroyed by 1959; if the present rate of destruction continues, 14 per cent will remain by the year 2000. At Sherwood Island State Park, Westport, Connecticut, 3.5 million cubic yards of gravel were taken from Long Island Sound by hydraulic dredging. Much of this gravel was used in the construction of the Connecticut Turnpike; the remainder obliterated the life of a marsh to create a parking area. Even the site of Kennedy International Airport was once a productive marsh.

Dredging and draining operations can also drastically affect the ecology of wetlands. Dredging causes increased turbidity, which decreases the amount of light that reaches photosynthetic organisms at the base of the food chain. Filter feeders such as shellfish may be adversely affected or actually killed. Suitable hard surfaces for the attachment of larval stages of shellfish may be covered by excessive sediment. The adverse biological effects on wildlife that result from widespread tidal-marsh ditching for mosquito control along the Atlantic coast are well documented. In Delaware natural marsh grasses were replaced by two shrubby species—marsh elder and groundsel. Mollusk and crustacean populations, important food of water fowl and other marsh birds, were reduced up to 95 per cent.

In Florida, drainage operations by large corporate developers are threatening the future of Corkscrew Swamp, a magnificent mature cypress forest owned by the National Audubon Society.

One needs only to look within one's own community to see where the sanitary land-fill operations are occurring to realize that wetlands are still regarded as wastelands.

Even those wetlands dedicated as natural preserves are being continuously subjected to encroachment. Troy Meadows is a classic example. Located in Morris County, New Jersey, 20 airline miles from Times Square, this 3,000-acre marsh—approximately half of which is held as a wildlife refuge by Wildlife Preserves, Inc.—is now being or is about to be subjected to the following encroachments: two electric transmission rights-of-way, two gas pipe lines, a sewer line, a pumping station, three water wells, and a dredging operation on one side of the meadows to speed the flow of odorous effluent from a nearby paper mill. Currently two highways, an interchange and access road are planned to cross part of the preserve. Work has started on one section. One utility plans to increase the width of its easement eight-fold. A pipeline official recently commented to Wildlife Preserve officers that this preserve was one of the best things that ever happened, for the land is kept open, acquisition is simplified, and land is cheap since it is not improved. As long as this attitude prevails our wetlands are doomed. But the question may well be asked: Can Troy Meadows, considered one of the finest wetlands in the eastern United

States, be saved, or will these continuing encroachments destroy the values for which the area was preserved?

Pollution. Wetlands have long served as our reservoirs for human and industrial wastes. To these we have added pesticides, "waste" heat, and an increased flow of nutrients from agricultural lands. The effects have been to accelerate eutrophication, simplify species diversity, and exhaust the oxygen supply, leaving only anaerobic organisms. In the Hackensack meadows the tidal marshes are dominated by a single species, reed grass or *Phragmites*. Here it appears that the more diverse marsh flora has been eliminated by pollution. Although of minor value for waterfowl, *Phragmites* still offers shelter and serves to catch sediments and minimize erosion.

Pesticides, especially insecticides, have markedly affected the ecology of wetlands. On Long Island, salt-marsh muds contain up to 32 pounds per acre of DDT after two decades of mosquito-control spraying. Biological magnification occurs at various trophic levels in the food chain from the phyto-plankton through the sea birds, and levels appear sufficiently high in the marsh muds at this time to be subtly eliminating certain organisms. Marine organisms, especially crustaceans, are extremely sensitive to the persistent pesticides. As little as 0.6 to 6 parts per *billion* will kill or immobilize a shrimp population in two days. A recent court case on Long Island has highlighted this environmental contamination by DDT and has led to a temporary injunction against the Suffolk County Mosquito Control Commission.

The osprey, closely associated with our coastal wetlands, has been rapidly declining in recent years. Here pesticides appear to be implicated. A study of marshes along the Connecticut River now reveals that only 0.5 young per nest are being reared compared to the normal 2.5 young, and the eggs contain 5.1 ppm DDT. In Maryland, hatchability is slightly better—1.3 to 1.6 per nest—and DDT levels in the eggs are lower, only 3.0 ppm.

Probably the most disturbing finding is the recent report that DDT reduces photosynthesis in marine plankton. The ecological implications may be of major significance in modifying species diversity, giving rise to explosive populations and aggravating already serious eutrophication. It may even result in subtle mortalities that might be difficult to determine by even the best sampling techniques.

Need for a National Wetland System

Private agencies such as the National Audubon Society, Nature Conservancy, Wildlife Preserves, Inc., Natural Areas Council, and Philadelphia Conservationists have all played a vital role in the preservation of such wetlands as Troy Meadows, the Tinicum Marshes in Philadelphia and East River Marshes in Guilford, Connecticut. The preservation of Great

Swamp, New Jersey, although it is now under federal protection, was initially sparked by a group of private citizens.

At the municipal level we see Jamaica Bay, a famous 3,000-acre marsh and water complex, as part of the New York City Park System. And in Hempstead, Long Island, 10,000 acres of tidal marshes owned by the town have been dedicated to wetland conservation through a joint program with the State of New York. In the town of Woodbridge, Connecticut, zoning prohibits the destruction of wetlands. Many towns have conservation commissions assisting in the preservation of the community's open-space resources, especially the wetlands. Land trusts are also being established, as in Guilford and Madison, Connecticut, where wetlands can be privately held or given to the town with certain legal restrictions.

Two states, Massachusetts and Rhode Island, have taken bold leadership in preserving tidal wetlands. The Massachusetts law prohibits dredging and filling the 45,000 acres remaining in Massachusetts. The Rhode Island law restricts use of coastal wetlands for the benefit of public health, marine fisheries, wildlife and other conservation purposes. In New York, the Long Island Wetland Bill provides funding up to 50 per cent of the total cost of development and 50 per cent of total cost of maintenance of town- or county-owned lands which have been dedicated for conservation purposes. Wetland legislation has been unsuccessful in Connecticut. However, Save the Wetlands Committee has a wetlands acquisition program underway.

At the federal level, recent estuarine legislation has authorized the Department of the Interior to inventory the nation's estuarine resources and set forth recommendations for a program of preservation. The Committee on Environmental Quality of the Federal Council on Science and Technology is currently considering means of resolving interagency conflicts in the use of the wetlands. Although there is a recognition of the problem, much bolder action is required if our wetland heritage is to be saved.

I should like to propose that we as a nation adopt a national wetlands policy. Economists now recognize that our productivity potential has reached such a level that the nation's economy and our high standard of living will not suffer by the preservation of such natural landscapes which will not only serve as an important natural resource but also enhance the quality of life for all Americans. Such a policy would give national recognition to the importance of wetlands. They would be inventoried, evaluated for the ecological role they serve, and vast acreages would be preserved in the national interest. Such a system might be patterned after the Wilderness system so that it could be defended against competitive land uses. This policy would, we hope, minimize conflicts of interest among government agencies and exercise certain controls over the private entrepreneur who may destroy for personal gain a resource of great value to the nation.

Until we have fully assessed these liquid assets we will be unable to determine what is the desirable wetland mix that should receive permanent protection. The possibility that our population will double within the next forty years makes this the decade for action. For the urban environment it will mean increased open space and maximum habitat diversity, and it will assure a higher level of environmental quality in perpetuity.

Greater familiarity with marshes on the part of more people could give man a truer and a more wholesome view of himself in relation to Nature. In marshes, life's undercurrents and unknowns and evolutionary changes are exemplified with a high degree of independence from human dominance as long as the marshes remain in marshy condition. Marshes comprise their own form of wilderness. They have their own life-rich genuineness and reflect forces that are much older, much more permanent, and much mightier than man.

—Paul L. Errington

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IN DEFENSE OF MUD*

Edward S. Deevey, Jr.

Dalhousie University, Halifax, Canada

Limnology, the study of inland waters, has been called one of the earth sciences, but I hesitate to stress that name in public. In an age that glorifies celestial mechanics, matters "of the earth, earthy" have to be etheralized before they appeal to earthlings. I suppose the PR trouble about *earth* science begins with the ancient notion of the four elements. Water, air, and fire—the admired constituents—can all be conceived as *pure*. But "pure earth" seems to be a contradiction in terms, earth being the one unpurifiable element that sullies everything else. My subject being a turbid mixture of earth and pure water, irreparably corrupted by germs, I find the public preoccupation with unearthly problems a little unrealistic; but it warns me not to try to make mud glamorous. It will be enough, I hope, to show that it is a necessary part of the worldly scheme of things.

Why mud? Briefly, my argument is that mud, the essential habitat of certain essential microorganisms, is just as important as water to the economy of this planet. Now this Commission, and the general public, are well aware of two kinds of reasons for the careful husbandry of water, and it is the occasional conflict between their rival claims that makes such a Commission necessary and desirable. The two kinds of demands, of course, are (1) what is legally but mistakenly called *consumptive use*, for physiological and industrial purposes; and (2) *recreational use*, which often requires a deliberate social decision to refrain from some or all consumptive use. When another member of this conference urges the Commission to adopt a "people-oriented" policy of water use, she is clearly referring to recreational use. And when a Commissioner makes the obvious rejoinder—"yes, but which people?"—it is competing needs for consumptive and for recreational use that he has in mind. Since mud may seem to go with water as the night with the day, it is not immediately evident that the conservation of mud is a third, and may be an overriding, kind of reason for the conservation of water. In fact, careful attention to the management of mud need not be a new, third kind of demand; intelligently applied, it can help adjudicate between conflicting claims on use of water.

Though perhaps unfamiliar, this idea is not really new, for it is a direct extension of the ecological or "systems" view of man in the natural world.

*Reprinted by permission from the Bulletin of the Ecological Society of America, March 1970.

Mud is not always and everywhere the same, and some essential microorganisms require kinds of muddy water that are inimical to other essential kinds. Because the microbes in question are all essential, a "microbe-oriented" policy of water use is a truly "people-oriented" policy, but one that focuses on aspects of global ecology that are genuinely important to all people. In a perspective as broad as this, it may be necessary to look past economic and political, and even past social and esthetic, considerations, which are often construed too narrowly.

Behind this assertion is a biogeochemical concept of man's ecology that I cannot take time to develop in detail. Some listeners, however, will be puzzled to hear an ecologist speak of social and esthetic considerations as "too narrow". To avoid misunderstanding, I must take five minutes to clarify my eco-political philosophy.

Some polemics. Far from denying the essential value of recreational use, of water as of wilderness or of any natural resource, I side with every conservationist in pressing the claims of environmental quality against the short-term benefits of economic development. Until very recently, all the political and most of the polemic advantage has lain on the side of that development which can rigorously assess its costs and benefits in economic terms. Today, nearly everywhere we look, we can see that whereas the benefits (for someone) may have been much as predicted, the costs, especially the social costs, were grossly underestimated. Because most developers, like the economists who serve them so well, are neither stupid nor vicious, but admit that they may have been short-sighted, honest attempts are now being made to avoid the mistakes of the past. The very existence of this Commission is evidence of a changing public view of water-resource development, a view that insists on broadening the base of decision-making to take proper account of concealed social costs.

Slowly at first, but lately with all the power of an idea whose time has come, recreational values, including the esthetic values of undisturbed landscape, are being taken seriously. Economists and planners who have done this have begun to find ways of touching the intangible and pricing the priceless. Apart from a certain crassness, this technique is beset with booby-traps—the social value of the whooping crane is not measured by what has been spent to preserve it—but no matter; some real progress has been made in evaluating social costs of resource development. As one result, as developers and legislators are startled to learn, all the polemic and much of the political advantage has shifted to the side of the conservationists.

So far, so good; no ecologist can be displeased if environmental-quality issues have at last acquired some political clout. What troubles me is that recreation, though necessary, is not a sufficient basis on which to sustain an eco-political cause. If the rallying objective is the restoration and maintenance of high-quality environment for *all* people, it is naive and

even dangerous to assume that recreational values are coextensive with demands for quality. If this point is not understood by the next generation of conservationists, the danger is that the cause will suffer damage at the hands of its friends.

Recreation and tourism: some reservations. The context of the argument being water-resource development, let me note first that it is *outdoor* recreation that is being talked about. I once served briefly as adviser to the Outdoor Recreation Resources Review Commission, and became uncomfortably aware how weak is the case—built mainly on nostalgia and a distinctly middle-class concept of mental health—for the *necessity* of outdoor activity. *Desirable* as it may be for the tiny fraction of an urban public that both wants it and can afford it, recreational use of the nation's water resources must, I fear, be classed as a luxury. To the degree that that is true, or is thought to be true by economists and planners, allowing recreational values of landscape to find their price in the market is a perilous course. For one thing, it places the preservation of the Everglades in competition with symphony orchestras and television for the public's "entertainment dollar". What is much worse, it lends bite to the argument from the ghetto and the tribal council, that national parks are white man's playgrounds, and sailing and fly-fishing are WASP amusements.

When recreation is not pure luxury, it is avocation. Contrary to a widespread impression, western society is still Calvinist, not hedonist; and in such a society, when the crunch comes, vocation will always receive higher priority than vacation from hungry or otherwise disadvantaged people. We may no longer consider recreation as vaguely sinful. Nevertheless, when old jobs are threatened or new ones are promised in a depressed area, it is hard to defend the pristine beauty of an unproductive countryside. Industrial development in Nova Scotia, where I live, provides some textbook examples of this cruel dilemma. In the long run, though, more permanent damage is done to man's ecology when tropical forest is destroyed for obsolete modes of agriculture.

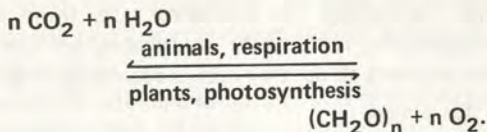
My most serious reservations about recreation stem from the close kinship between recreation and tourism. Tourism, of course, is the pattern of development favored when the natural resources of a region seem incapable of supporting people in any more lucrative way. So relatively modest, and *very unequally distributed*, benefits are accepted in advance as if they were part of the natural order. The psycho-social cost of such dependency is parochialism or paternalism, depending on the angle of the viewer. When the benefits of tourism flow, *unequally*, across international boundaries—I am thinking of Nova Scotia's salmon fishery, as well as of Mexico and the Caribbean—the social and environmental costs have a way of staying home with the natives. An uglier term for this sort of patron-client relation is *economic peonage*. With respect to Latin America,

or any part of the world where poverty can be exploited for its picturesqueness, tourism is simply one of the less offensive forms of American cultural arrogance.

Back to microbes.* I have said that a "microbe-oriented" policy of water management is sounder, ecologically, than any mix of political compromises that attempts to harmonize recreation with consumption. To explain this idea, and the defense of muddy water that it implies, I can build on the familiar concept of the "balanced aquarium".

Recycling, or the interconversion of natural resources and garbage, is the name for the set of key processes that insure the biochemical balance of "Spaceship Earth." The reason that mud is just as important as water is that certain microbial forms of the enzyme *hydrogenase*—the essential catalysts of interconversion—occur only in muddy environments that are lacking in free oxygen.

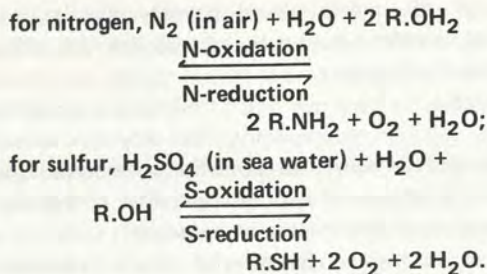
For oxygen and carbon dioxide—the respective "by-products" of plants and animals—the balance-aquarium model is simple and explicit:



Carbohydrate, the "primary photosynthate", according to the school-books, is both the fuel that powers animals' activities, and the foundation block for other organic compounds. The chemical energy contained in carbohydrate is radiant energy from sunlight, captured and transformed, uniquely, by green plants. Though incontrovertibly true, these statements conceal a dangerous misapprehension: the idea that balanced living systems *consist of* animals plus plants. As long as the sun shines, and the plants are green, it seems to follow that animals, and people, have nothing to worry about. The truth, of course, is that no living system is ever balanced without microbes.

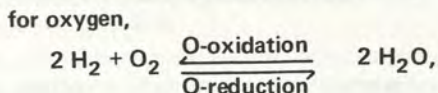
What makes the apparent balance misleading is the fact that living substance is more than carbohydrate. The assembly of proteins, for example, requires, in addition, nitrogen and sulfur. If we let R stand for any fragment of a carbon compound, we can condense whole libraries of biochemistry, and say that *all* proteins are made of R.NH₂ and R.NH₂.SH. Note that the nitrogen and sulfur in these amino-acids occur in reduced, or hydrogenated, form. Treating the two elements separately (because, in the world outside the aquarium, their main supplies are separate), we can elide some other details and write closed cycles for each:

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For these three elements, then, interconvertibility is reversible oxidation and reduction; garbage is reduced to resources with oxygen as a by-product. And, as $\text{C.OH}_2 = \text{R}$, there is a symmetry here that concerns all consumers of oxygen.

In an oxidizing atmosphere, or ocean, R (= "organic matter") is easily destroyed by oxidation, driving the three equations toward the left. Reduction, using solar energy to drive the equations toward the right, is chemically more interesting. To a chemist, the three reductions, *all performed by organisms*, are equally improbable, for the enzymes that reduce the three elements all do it by dehydrogenating water:



(and water therefore enters as a reactant on both sides of the three equations). For the ecologist, though, or for any inhabitant of Spaceship Earth, life works through an improbability of another order. The three different kinds of hydrogenase, those that reduce carbon, nitrogen, and sulfur, occur in different organisms that live in different places.

What follows, if $\text{R.NH}_2.\text{SH}$ is to remain a renewable resource, is that water, mud, air, and land are closely linked by oxidation-reduction cycles in which reduction is performed entirely by organisms. Or, to put the matter in another way, not all the oxygen in the atmosphere is made by green plants. Some is necessarily made by nitrogen-fixing and sulfate-reducing bacteria in soil, lakes, swamps, and the sea. Sulfate and nitrate, in particular, are mainly reduced in mud, where free oxygen (poisonous to such bacteria) is absent. Linkage, between mud and air, is the escape of gaseous hydrogen sulfide, H_2S , and ammonia, NH_3 . By the time these compounds are washed out of the atmosphere, however, they have been oxidized back to sulfate and nitrate.

Wetlands and water policy. To my intense regret, instantaneous recipes for action do not emerge from what is presently known of microbial ecology in lakes. It is not difficult to write down chemical equations for biological recycling. It is another matter entirely to measure, on a global scale, the *sizes* of biochemical supplies and the *rates* of processes that link

them. Until some meaningful biogeochemical budgets can be drawn up, no one can specify, for any particular body of muddy water, what fraction of the world's hydrogenase is threatened by mismanagement. One can only guess—from studies of Linsley Pond, Connecticut, for example, where sulfur metabolism is about one-tenth as active as carbon metabolism—that the fraction is large enough to warrant prudence.

Lake mud, as I have said, is not all alike, and at present its fascinating diversity stands in the way of quantitative balance-sheets. For example, Linsley Pond mud releases none of its substantial output of sulfide to the air, or even to the lake water, owing, we believe, to abundant iron dissolved from the local Triassic rocks. But I know of a Nova Scotia lake, polluted by a paper mill, that releases enough hydrogen sulfide to kill trees and enough sulfuric acid to corrode concrete.

Of course, in a comprehensive view of lakes as parts of landscapes, such differences imply the possibility of trade-offs in management. The segment of the nitrogen cycle that is blocked when a forest is drowned behind a dam may be restored, with an unearned and probably unwanted increment of sulfide, when the lake is eutrophic enough to support both blue-green algae and anaerobic mud.

One implication of this line of reasoning is that eutrophication is not always and necessarily bad. In seriously polluted lakes such as Erie the process can be and must be arrested, for the sake of the public health, the fisheries, and the recreational use. But when I think of its bottom as a habitat for microbes, I am confident that reports of Lake Erie's death are premature, and even in its present repulsive state it may be performing unsuspected functions.

But the mud that underlies the open water of lakes is not the only habitat of anaerobic bacteria. Swamps, marshes, and estuaries probably contain more hydrogenase, and certainly occupy more area within the continental United States. For these wetland systems, I believe, though I cannot prove it quantitatively, prudent management requires rigorous defense against further encroachment. Nearly half of their pre-colonial area has already been lost to drainage and other oxidizing development, and the destruction proceeds apace, in the inland states as in the coastal zones. It is hard to find a better illustration of the fallacy, that undeveloped land is waste land.

Among the essential functions of wetlands, as 20-20 hindsight has shown in such states as Massachusetts, ecologists usually give first place to their role as a hydrologic safety-valve against disastrous flooding. Partisans of ducks and fiddler-crabs may be startled when I suggest, in addition, that the most valuable inhabitants of wetlands are sulfate-reducing bacteria. But I do not think the claim is overdrawn, simply because, while the acreage of their habitat has been restricted by half, the amount of airborne sulfur they have to process has been more than doubled by industrial

pollution. Evidence that wetland systems are beginning to jam appears wherever mud and peat are corroded by sulfuric acid.

For wetlands, then, if not yet for the muddy bottoms of lakes, systems ecology offers some guidelines for socio-political action. To the last generation of conservationists, the haunts of coot and heron seemed to need no reasoned defense from anybody. Henceforth, I believe, the "new conservation" can take a more worldly stand. Its basis is that hydrogenase, like water and oxygen, is no longer a "free good", but a commodity more precious than we know.

The coastal and fresh-water marshes bring together many kinds of life, and some are rivals for the same type of food. Many become food for larger animals. All the plants and animals mentioned have a place in this complicated pattern, this food web. Ecologists, the scientists who study these interactions and dependencies, attempt to interpret the total marsh environment—water, soil nutrients, and air—as well as the plants and animals in the ecosystem. One eminent ecologist has observed that this interacting complex, the ecosystem, is not merely more complex than we think, but rather more complex than we can *think*.

—William A. Niering

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THE BANTAM RIVER*

Accumulating Value by Covenant

The Bantam River is a prominent and lovely feature of the still rural countryside near the village of Litchfield, Connecticut. Though it cuts through farmland and the residential area of the village, the stream is generally wild, unfettered, freeflowing. Its character varies according to the immediate terrain. Here it flows past a small cattail marsh bordering a low, broad floodplain. Around the next bend, its banks become steep and rocky, covered with a dense grove of mature hemlock.

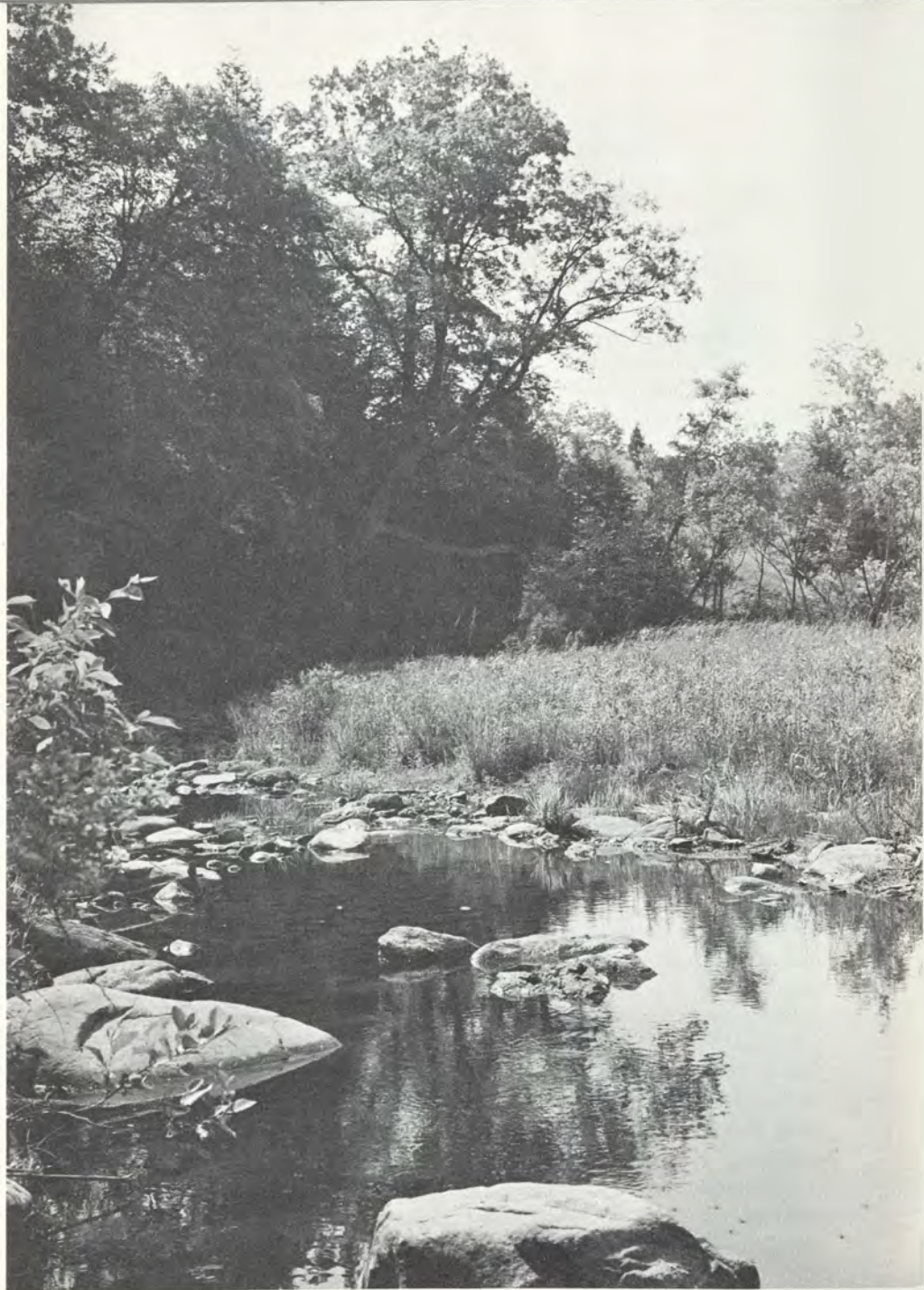
For the most part, the houses and other buildings of Litchfield do not intrude on the Bantam, but are set on the higher land some distance away. North of the village, the property of Dr. Sydney R. Kennedy, Jr. borders a quarter-mile stretch of the river. Woods and fields slope from his home to the East Branch. The land is wild. Dr. Kennedy, an amateur botanist, writes: "The existence of a 'wilderness area' even in miniature near to me seems to be close to a personal necessity and should it disappear I think I would remove myself elsewhere."

A half mile away, on the West Branch, Mrs. Charity Wilson has another reason for cherishing her property. "My whole family, children, grandchildren, and I get a great deal of pleasure from the river, through all the seasons of the year," she says.

Downstream, the channel of the Bantam cuts through the village itself. Houselots between South Street and the river are not so generously proportioned as those upstream, but along the river the land has remained largely wild and natural. To Edward and Mary Hall, the woods behind their home are reminiscent of the kind of open country so easily accessible when they were growing up and now so fast disappearing. Says Mr. Hall: "I would like my grandchildren to have wilderness to walk in, solitude to feel a little bit frightened in, wild things to see and hear and feel and make a little boy feel very little indeed." Remembering her own childhood, Mrs. Hall feels constrained to add, "Little girls may not go as deep into the woods, but I think they get just as much fun out of it."

Obviously, these owners share more than a riparian location. They share a common sense of stewardship, a feeling that their land should be preserved at least in part in a wild state. They also share the realization that their lands are linked by the narrow stream valley in a common fate,

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"... to place permanent restrictions on a strip of river valley so as to preserve its naturalness."

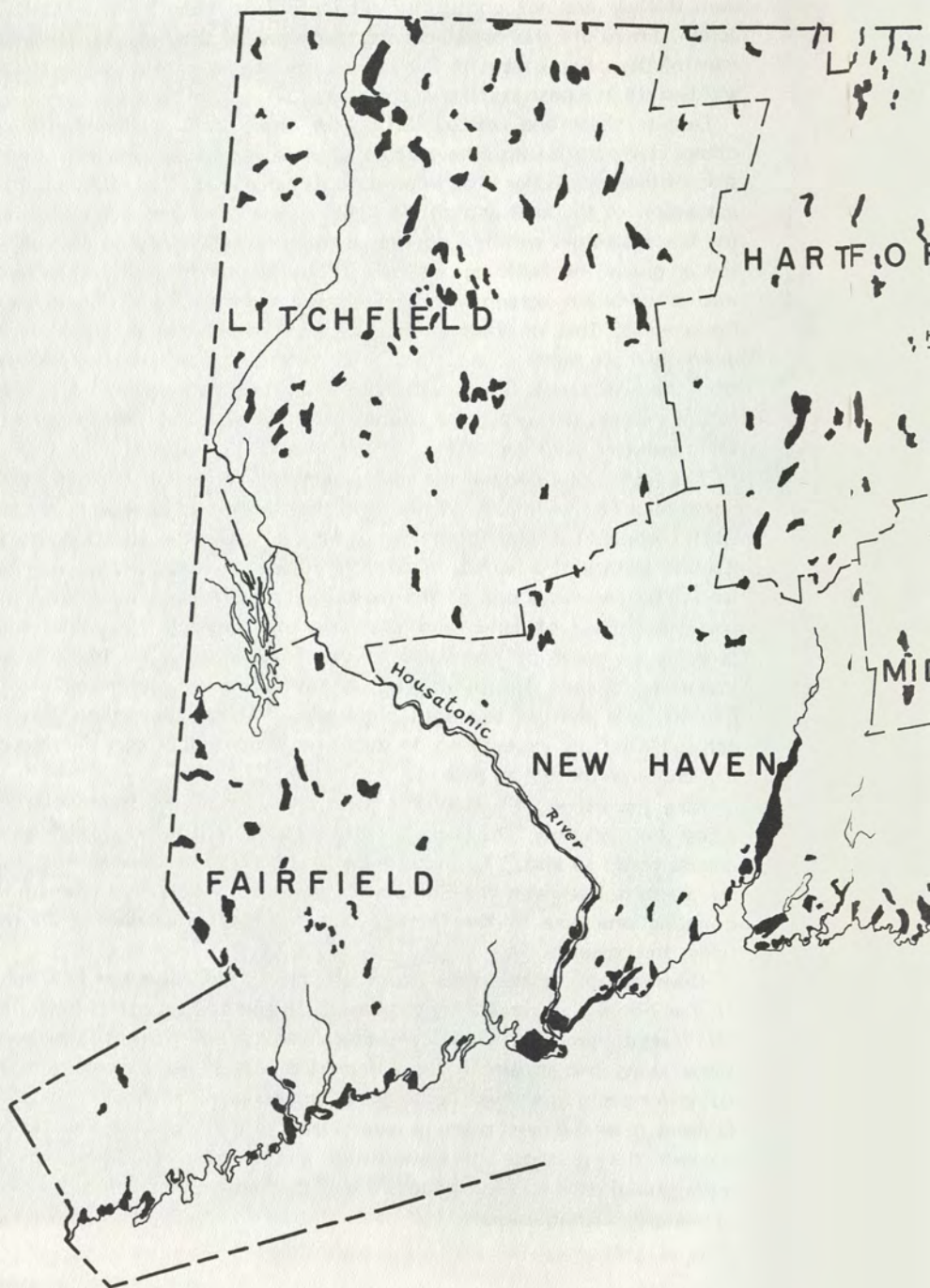
even if they are not contiguous. The problem: How to take effective action. There are the complications that some of the holdings are small, most of the owners want to live on the land, some want to sell part of it, and few are in a position to give any away.

Despite these and related difficulties, these three owners and seven others along the Bantam have acted to place permanent restrictions on a strip of the river valley so as to preserve its naturalness. They have retained possession of the land and all the rights to use it and enjoy it except for the few restricted actions: no tree cutting, no billboards, no removal of soil or gravel, no buildings or roads. These ten landowners have entered into a common agreement, known as a covenant, with The Nature Conservancy, Inc., of Washington, D.C., under which they have voluntarily given up these rights on a strip of land extending approximately 200 feet from the river's edge. Because the covenant "runs with the land" and binds future owners, the agreement assures them that their stewardship will have some enduring significance.

The fact is that none of the landowners feels he has sacrificed anything. Some, like Dr. Fowler F. White, rate their action as somewhat minimal when compared to large donations of land by philanthropists. Thomas C. Babbitt admits of a selfish motive, "I think it increases the value of my land. The river was one of the most important reasons for buying this particular piece of land, and anything that protects its natural state protects an asset of real value to me. I think it is also likely to be important to any future buyer." A further reason, according to Mr. Babbitt, was that of setting a precedent. "I hope that others may be persuaded by my example to do the same, which will protect the river on my land even more," he adds.

Like the others, Mr. Babbitt's basic motive is one of preservation. "I enjoy the river now," he says. "I hope that future generations will have a chance to do so also." To increase the likelihood of his hope coming true, Mr. Babbitt has given the Bantam River project added legal strength by donating one acre to the Conservancy outright, while placing the rest under the covenant.

Downstream, at the other end of the project, Mr. Sherman P. Haight, Jr. has donated a similar "anchor acre" to give the covenants longevity. Mr. Haight lives in the village, where already a few changes have taken place along the stream in the commercial section. With the others, he could foresee a time when housing and commerce might eliminate what he believes to be the most precious natural asset of the Litchfield area. It now appears that a sense of stewardship and a corollary willingness to anticipate change is winning the battle of the Bantam even before the signs of war are much in evidence.



LITCHFIELD

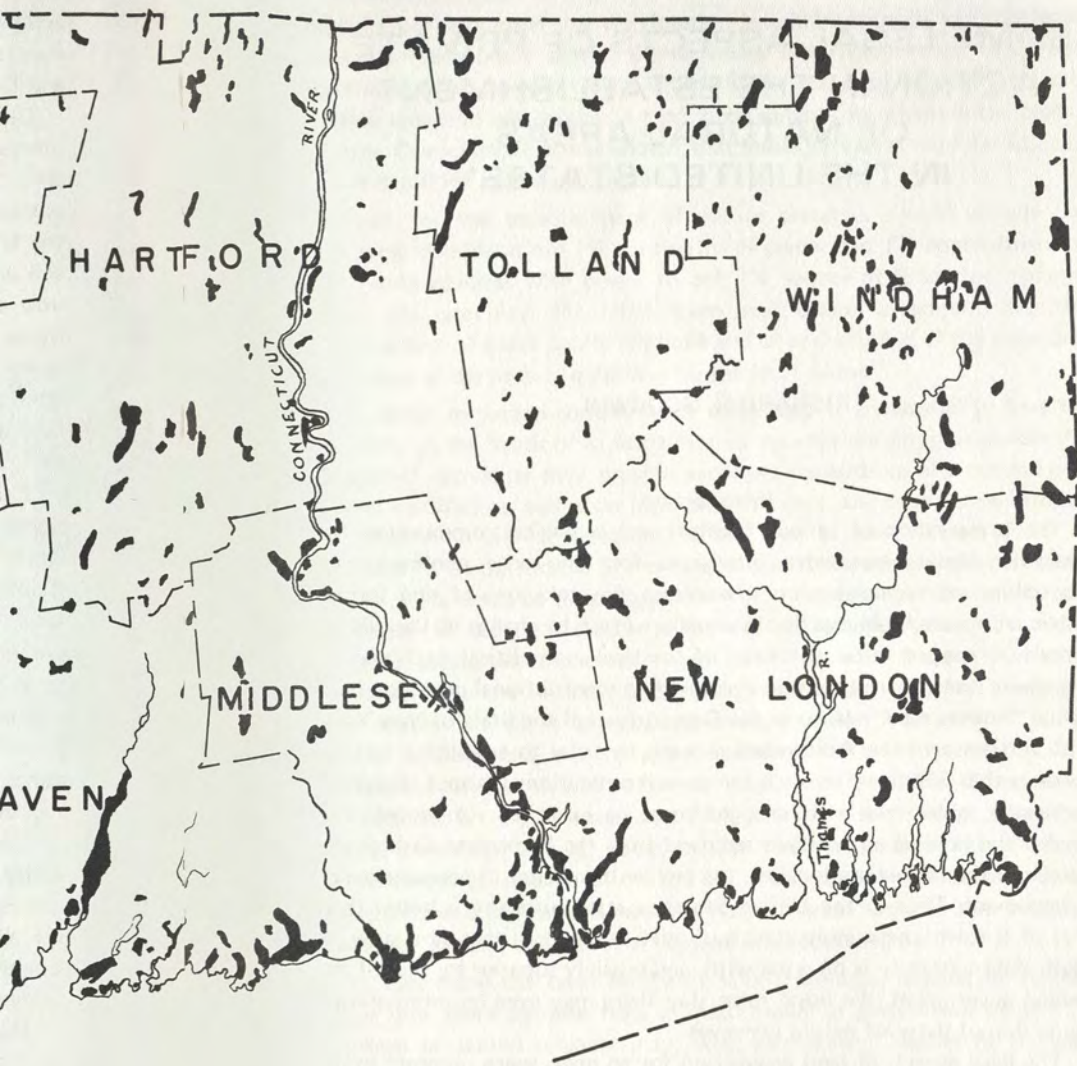
HARTFORD

FAIRFIELD

NEW HAVEN

Housatonic
River

MIL



Inventory of Connecticut's larger wetlands compiled by Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. Modified from WETLANDS OF CONNECTICUT, 1959. Published by U.S. Department of the Interior, Branch of River Basin Studies, Boston, Mass.

SOME LEGAL ASPECTS OF PRIVATE ACTION IN THE ESTABLISHMENT OF NATURAL AREAS IN THE UNITED STATES*

RICHARD H. GOODWIN

Introduction

The preservation of unique habitats and biological communities for scientific study necessitates provisions for long-range continuity of ownership and administration. Ownership may take one of two forms: public or private. Public action is usually subject to change at the will of those who happen to be in control of the legal and political machinery at any given time, however, unless it is tied to a constitutional provision such as the "forever wild" clause in the Constitution of the State of New York with reference to the Adirondack Forest. In order to establish a natural preserve that will carry through for several generations without change or perversion, great care and foresight must be exercised. In general, the further the holding authority is removed from the immediate wish of the people in the immediate locality, the greater the chance of permanence of management. Thus in the United States, a state authority is better than that of a town and a multi-state authority better than that of a state. A multi-state authority is on a par with, and possibly superior to, that of the federal government. We hope some day there may even be international ownership of the great nature preserves.

The legal aspects of land acquisition for an open space program in the New York Metropolitan region has been recently covered by a book by Shirley A. Siegel entitled "The Law of Open Space." Although it claims to be a comprehensive treatment, this reference deals only with public acquisition. It is recommended to the reader for coverage in this area. The present paper will be restricted to the role of private enterprise in the creation of preserves in the United States.

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In any discussion of the legal aspects of natural area preservation, it must be borne in mind that the situation will differ radically with the legal codes of the country and of the territorial subdivision within which the tract is located. In most of the United States the code is based upon the English common law, which, in turn, finds some of its origins in the feudal system. Our experience has shown that these problems must be worked out in detail for each separate state.

Plans for the establishment of nature preserves should include the following consideration: (1) continuity of ownership; (2) appointment of watch-dog agencies with power to act; (3) source of funds for management; (4) provision for relief from real estate taxes; and (5) the development of good public relations and of appreciation of the value and objectives of the project especially by the local people.

In order to secure continuity of ownership it is essential to have the property in the hands of an institution or appropriate group of people. An interested individual may provide excellent stewardship of a natural area during his lifetime; but upon his death title may pass to someone who has no interest in the preservation of the area or who cannot afford to maintain it. In the United States inheritance taxes on valuable real estate may in some cases be so burdensome that the property must be sold to a developer in order to discharge the tax obligation. Among the many privately supported conservation agencies in the United States, The Nature Conservancy is the national organization especially dedicated to natural area acquisition. It is a membership organization incorporated in the District of Columbia, and enjoys tax exempt status under federal and state income tax laws. It should not be confused with the Nature Conservancy of Great Britain, a public agency which is doing a splendid job of natural area preservation through governmental techniques. The United States' Conservancy is now the owner of about seventy preserves. Other conservation organizations holding natural areas include the National Audubon Society, and a host of regional and local societies.

In discussing the need for "watch-dog" agencies, it must be remembered that there are also risks in institutional or government ownership. Trustees or public servants may, with carelessness, neglect or changing circumstances, or for reasons of expediency, abandon the maintenance of a natural area, permit encroachments or even dispose of the property, unless carefully built-in legal restrictions are imposed at the time the preserve is established. Disturbing instances of breach of the real intentions of donors have been committed in the United States, even by some of the outstanding educational institutions, which took advantage of inadequately designed terms of gift. Not only should the terms be carefully spelled out; but "watch-dog" agencies should be appointed with power to act in cases of infraction. Reverter clauses and covenants are devices which

sharpen the "watch-dog's" teeth. In certain instances it is also desirable to designate an alternate agency in case the initial one becomes dissolved.

Where possible the provision of funds for management of a natural area is desirable. Sometimes this can be achieved through an endowment and sometimes through some revenue-bearing asset connected with the property.

Exemption from real estate taxes can be a matter of the greatest importance to the long range security of a natural area. If this is not obtained, real estate values and assessments may climb to the point where it is no longer possible for the agency owning the area to meet the tax payments. In certain states, such as New York and Pennsylvania, The Nature Conservancy, as a corporation with charitable, educational and scientific purposes clearly enjoys exemption from real estate taxes. In some of the New England States (notably Massachusetts and Connecticut), on the other hand, it has been necessary to establish locally incorporated subsidiaries in order to secure this status. In other states, such as New Jersey, tax exemption has not yet been granted for private natural area holdings. In such a state the only possibility of *preservation* in the case of a natural area of substantial real estate value is to place ownership in a governmental agency.

The importance of good public relations in natural area preservation cannot be overemphasized. Legal techniques may fail where local understanding and support are lacking. Thus educational programs aimed at gaining such understanding are essential. Examples of encroachment on established preserves are numerous. Vandalism and poaching can often only be controlled through the vigilance of neighbors and the cooperation of police, game wardens and the courts. Government condemnation is another hazard. Thus Tucker Prairie, acquired by the University of Missouri as a research facility, was threatened by an interstate highway shortly after its establishment. Strong protests from The Nature Conservancy and others, although reducing the extent of the encroachment were unable to prevent it. A state highway threat to the natural area in Glen Helen at Antioch College, Ohio, has been at least temporarily fended off, thanks to a major campaign on the part of College alumni, local citizens, and conservationists throughout the nation.

Three types of legal instrument may be employed to secure long-range continuity of land use pattern for a natural area in private ownership. These are the deed, the will and the contract. The Nature Conservancy has made use of all three of these devices within the last few years and some of these cases will now be described. The natural areas program in the United States is especially indebted to Mr. Belton A. Copp and his associate, Mr. Russell Brennehan, for their part in the preparation of a number of legal documents, some of them quoted in the appendices, and to Mr. Elting Arnold, the Secretary of The Nature Conservancy, for his legal counsel in general.

Case histories

I. Deeds

1. *Reverter clauses.* A piece of property may be acquired by an agency through gift or purchase, but with restrictions imposed by the donor or seller (grantor). If they are to be truly effective, these restrictions must be more than statements of intent. They must be legally binding. The Nature Conservancy has acquired a number of pieces of property with restrictions so imposed. In the case of the Burnham Brook Preserve in East Haddam, Connecticut, the donors provided that in the event that The Nature Conservancy should wish "to abandon the property or to sell or transfer it for any purpose other than as a "natural area", another conservation agency would be given the "right, power and privilege" of purchasing the property at a stated price. The text of this clause is given in Appendix A.

The grantors of the original tract forming the heart of the 7,000-acre Northern California Coast Range Preserve in Mendocino County, California, inserted many stipulations with respect to the preservation and management of the preserve into the purchase contract. In this instance the purchase price was only a small fraction of the appraised value of the property. In essence the contract establishes a management committee, composed of a representative of the donor, a representative of The Nature Conservancy and an independent person. If any of the provisions of the contract were not fulfilled by the Conservancy, title would pass to a succession of other non-profit organizations.

In a number of instances groups have purchased real estate and then conveyed it to institutions with restrictions secured by reverter provisions.

The Mamacoke Natural Area of Connecticut College in New London, Connecticut, is an interesting example. Here the deed provides that upon the failure of the College to observe the conditions of the gift, title shall pass over to either of two successor agencies, one of them The Nature Conservancy. There is a further provision that if the College wishes to dispose of the property, it must first offer it for sale to each of these watch-dog agencies at a price not to exceed \$500, provided they are prepared to maintain the preserve under the stipulated conditions. The pertinent portions of this deed are given in Appendix B.

The William L. Hutcheson Memorial Forest (Mettlers Woods) in Somerset County, New Jersey, given to Rutgers University, together with an endowment to support research on the area, is similarly protected. In this case both the land and the endowment fund are forfeited by the University, if the terms of the trust are broken. The Nature Conservancy is named as the ultimate beneficiary in case the project must be abandoned.

The Nature Conservancy itself has frequently transferred property to other agencies, usually institutions of learning, which are in a position to utilize it for study and to protect it. For instance, the Volo and Wauconda Bogs in northern Illinois were deeded to the University of Illinois with

reverter restrictions. The standard reverter clause approved by the Board of Governors for use in cases such as this is given in Appendix C.

2. *Covenants or Trusts.* Occasionally the reverter clause cannot be used as a legal device. Certain states, for instance, may not accept land with reverter restrictions because it is contrary to their statutes. In such cases a *covenant* or a *trust* can be used. A covenant was employed when Pine Hills, a 600-acre scenic area adjacent to the existing Shades State Park, was turned over to the Department of Conservation of the State of Indiana. The covenant provisions are set forth in two quit-claim deeds that appear in Appendix D.

3. *Easements.* The easement is an old and well established device. It gives an individual or agency certain rights and privileges on a piece of property, without involving outright ownership. A familiar example is the electric power-line easement, permitting the utility company access to the right-of-way for installation and maintenance of the lines while restricting the activities of the owner on the right-of-way. A conservation easement may give an agency the exclusive right to do certain things which would be damaging to the integrity of the natural area and therefore restrains the owner from so doing. It may also reserve to the owner certain rights and privileges. Thus The Nature Conservancy has been given certain rights to a piece of unditched salt marsh in Old Mystic, Connecticut (Appendix E [1]), and to a piece of woodland in Norfolk, Connecticut (Appendix E [2]). The reservations of the owner in the latter case are of especial interest.

II. Wills

A landowner may provide that his property become a natural area upon his death through a testamentary trust. Such trusts have been drawn up for the establishment of three natural areas in Connecticut. The wills provide that the properties be administered by self-perpetuating Boards of Trustees which will have as their responsibility securing proper management for the properties. In each case provisions for endowments have been made. In one instance a letter of intent, setting forth the wishes of the donor, has been placed on file with the donor's will for the guidance of his Trustees.

III. Contracts

These are legal agreements mutually binding upon all the parties involved. Where a conservation agency can be included as one of the participants, the contract can become very difficult to dissolve. A group of citizens in Litchfield, Connecticut, are presently attempting to preserve the Bantam River in its beautiful unspoiled state. Two small pieces of land are to be deeded to The Nature Conservancy at either end of the project. The Conservancy together with all the other land owners will then sign a mutual agreement for the preservation of the area that will be binding on all the land owners, their heirs and assigns. The covenant provides for the

permanent protection of a strip of land 200 feet wide along each bank of the stream. For the specific provisions, see Appendix F.

APPENDIX A

Restrictive clause in Warranty Deed conveying property in East Haddam, Connecticut to The Nature Conservancy, Inc.

"Said premises are further conveyed subject to the restriction, condition, covenant and easement, which shall run with the land during the life of the survivor of the grantors' children living at this time: if the grantee, or its successors or assigns, shall ever decide to abandon the property or to sell or transfer it for any purpose other than for use as a "natural area," the grantors hereby expressly reserve from this grant, and give and grant to The Conservation and Research Foundation, Inc., a Massachusetts corporation, or its successors or assigns, the right, power and privilege of purchasing this property from the then owner or owners for the sum of Two Thousand Dollars (\$2,000.00); this restriction, etc., may be waived and terminated, and the property transferred thereafter with no reference to this paragraph, by written notice to that effect to the then owner or owners by a majority of the Board of Trustees then serving on said The Conservation and Research Foundation, Inc., or its successors or assigns; if said corporation is defunct, and no one is able to act in such a way as to waive this restriction, etc., as aforesaid, or to exercise the right, privilege and power given it hereunder, then also may this restriction, etc., be declared void and of no effect by any court of competent jurisdiction on the proof of such facts."

APPENDIX B

Portion of the Mamacoke Island Deed conveying property to Connecticut College for Women, New London, Connecticut

This property was quit-claimed to Connecticut College for Women, its successors and assigns, ". . . while, until and so long as said releasee, its successors and assigns, use the hereinafter described property as an arboretum for recreational, educational or scientific purposes, said land and salt marsh remaining substantially in its wild character with its natural features preserved, and while, until and so long as no roads or ways are built or established, except paths for pedestrian and/or equestrian use only, all the right, title, interest, claim and demand whatsoever as I, the said releasor, have or ought to have in or to all that certain tract of land situated in the Town of Waterford, with any appurtenances, emblements, fructus naturales, fixtures, and improvements thereon standing, known as Mamacoke Island, and described as follows: . . .

Upon the failure of any of these conditions or limitations then said property shall pass over subject to the conditions and restrictions of this deed to the Connecticut Forest and Park Association or its successors or

successor by merger or consolidation, if in existence, or if not, then to the Nature Conservancy or its successors or successor by merger or consolidation, providing, however, that the releasee, its successors or assigns, is hereby expressly empowered to transfer and convey all of its right, title and interest in said premises for no consideration, or for a consideration of less than *Five Hundred Dollars* (\$500.00) in money or value, to either of the above-named organizations or their successor willing to accept said premises for the purposes described and on the conditions hereinbefore set forth, said premises to be offered to the organizations or their successor in the order they are listed above by a registered letter addressed to the secretary of the organization annexing a copy of this deed; on the failure of all the above mentioned organizations to elect to receive and maintain said property for said purposes, which election if made shall be in writing and shall be delivered to the releasee within ninety (90) days from the date the said offers as aforesaid were made to said organizations respectively, said releasee, its successor or assigns, may transfer and convey said premises or any part thereof by sale, mortgage, lease, gift or pledge to any person, persons or corporation and for any consideration, free of all conditions and limitations; in such event said conditions and limitations are terminated and are of no force and effect.

In the event that said premises are taken by process of eminent domain for public purposes, all proceeds realized as damages and compensation for such taking in any such action, or as a result of any such action, shall be kept by said College as an endowment fund, to be administered by the trustees of said College, the income of which is to be used for the maintenance and development of the Connecticut Arboretum for as long as an arboretum is maintained by said College, and in the event that said College shall no longer maintain an arboretum, then thereafter the principal and income of said endowment fund, may be used for the general purposes of said College.

It is the intention of the releasor that these premises be part of the Arboretum of the College, and be used for arboretum purposes as hereinbefore set forth, since it was only through the contributions of the many generous people who gave money to acquire land for these purposes that the purchase of these premises was made possible. Provision is made, however, for the contingency that should management of these premises for such purposes prove to be totally impracticable the releasee may transfer said premises as hereinbefore set forth."

APPENDIX C

Standard Reverter Clause adopted by the Governing Board of The Nature Conservancy

This conveyance is made subject to the express condition and limitation that the premises herein conveyed shall forever be held as a nature

preserve, for scientific, educational, and esthetic purposes, and shall be kept entirely in their natural state, without any disturbance whatever of habitat or plant or animal populations, excepting the undertaking of scientific research and the maintenance of such fences and foot trails as may be appropriate to effectuate the foregoing purposes without impairing the essential natural character of the premises. Should the premises cease to be used solely as provided herein, then the estate hereby granted to the, its successors and assigns, shall cease and determine and shall revert to and vest in The Nature Conservancy, its successors and assigns, the said reversion and vesting to be automatic and not requiring any re-entry or other act or deed.

APPENDIX D

Covenants included in the Quit-claim deeds conveying Pine Hills

1. Harley H. Hasselman to The Nature Conservancy as Trustee.

"The above described lands shall be and considered as a memorial to the memory of Frank G. Hasselman, and a suitable monument, of a design approved by the Department of Conservation, State of Indiana, shall be erected by The Nature Conservancy on said lands in a location selected by said heirs and approved by said Department;

Subject, however, to the express conditions and limitations that the lands contained in the premises herein conveyed shall be maintained in their natural state, undisturbed by hunting, trapping, organized camping, grazing of domesticated animals, timber cutting, removal of dead, dying or fallen trees, artificial planting for reforestation or landscaping, or any other activities that might adversely affect the physical habitat or the plant or animal populations of said premises, except that primitive foot trails may be provided and that parking and related facilities for the public may be constructed within fifteen hundred (1500) feet of the existing public road bordering the west side of the premises.

Activities conducted for scientific or educational purposes shall be permitted only when in accord with the limitations above set forth, and deemed proper by the Department of Conservation, State of Indiana, and approved in writing by an official of the Division of State Parks, Lands, and Waters, or its successor, of said Department.

In the event that grantee, The Nature Conservancy, or its successors or assigns, particularly the State of Indiana, should violate any of the foregoing covenants, the right to enforce said covenants or to enjoin the violation of the same shall vest in the grantors, their heirs, assigns, and successors, and particularly The Nature Conservancy after said tract is conveyed to the State of Indiana, by the remedy of mandatory injunction or by appropriate action at law."

2. The Nature Conservancy as Trustee to the State of Indiana.

"The above described lands shall be and considered as a memorial to the memory of Frank G. Hasselman, and his heirs shall have the right to erect a suitable monument, at their expense and of a design approved by the Department of Conservation, State of Indiana, on said lands in a location selected by said heirs and approved by said Department.

This deed is executed to the grantee by the grantor as trustee in full satisfaction of trusts created in deeds of . . . , and this conveyance is made subject to the covenants, restrictions and conditions in said deeds contained."

APPENDIX E

Easements to the Nature Conservancy

1. Corinne Gallup Easement for Salt marsh in Old Mystic, Connecticut.

"I, Corinne Gallup, . . . , do hereby give and grant to *The Nature Conservancy of Connecticut, Inc.*, its successors and assigns, while, until and so long as *The Nature Conservancy of Connecticut, Inc.*, its successors and assigns, use the hereinafter described property as a nature preserve for recreational, educational, or scientific purposes, in substantially its wild, natural character, and while, until, and so long as no improvements, excavations, filling, roads or ways are made, built or established thereon, except paths for pedestrian use only, a permanent and perpetual easement for the purpose of use as a nature preserve, as aforesaid, in and to a certain parcel of land situated on the easterly side of the Mystic River in the Village of Old Mystic, Town of Stonington, being bounded and described as follows: . . . "

2. Happy Kitchel Hamilton Easement for woodland in Norfolk, Connecticut

"I, *Happy Kitchel Hamilton*, . . . , do give, grant, bargain, sell and confirm unto *The Nature Conservancy*, and unto its successors and assigns, a permanent and perpetual easement to use as a natural area for scientific, educational and cultural purposes the hereinafter described land while, until and so long as such land shall be preserved in its wild and natural state and kept free of all human interference except for pedestrian foot trails and while, until and so long as there is no commercial or industrial development of any part thereof, there is no removal of sand, gravel, topsoil, minerals or other alteration of the land surface of any part thereof, there is no motorized transportation and no construction of roadways for motorized transportation thereon, there is no cutting of timber or removal of decayed or dying timber therefrom, except as may be necessary to the maintenance of pedestrian foot trails, there is no grazing by domestic livestock thereon, there is no hunting or killing of wildlife (except of what may upon due consideration of the grantee, or its successors, be considered an overpopulation of a given species) thereon; and there is no other activity thereon inconsistent with the preservation of

such land in its wild and natural state, such land being situated in the Town of Norfolk, County of Litchfield and State of Connecticut and being more particularly bounded and described as follows: . . .

Notwithstanding the foregoing conditions or limitations, the grantee may use a portion of such land not exceeding ten per cent of its total area (including as part of such portion land set aside for a homesite pursuant to the terms hereof) to modify some aspects of the total natural conditions in order to preserve, modify, encourage or create some special natural phenomenon or condition, such as a particular plant or animal species or community, a drainage condition such as a pool or swamp, or a vista or view. Such portion may consist of separate parcels, which need not be contiguous. The decision to utilize any of such land in accordance with the terms of this paragraph shall be irrevocable.

In the event that the grantee or its successors shall cease to use such land for the purposes aforesaid (mere lack of use compatible with its preservation as a natural area not to be construed as cessation of use) or shall affirmatively abandon its rights to such land or shall cause or permit alterations or changes not in accord with the restrictions and limitations herein (including such intensive human use as would alter the natural conditions) or upon the failure of any of such conditions or limitations, such property shall pass over, subject to the conditions and restrictions of this deed, to the Connecticut Forest and Park Association, or its successors or successor by merger or consolidation, if in existence, or if not, then to National Audubon Society, or its successors, or successor by merger or consolidation, if in existence, or if not, then to The While Memorial Foundation, or its successors or successor by merger or consolidation, if in existence.

This easement shall be appurtenant to other land of the grantee in the area known as "Beckley Bog".

The grantor reserves for herself, her heirs and assigns, an option or privilege to have set aside from such land and free of this easement a parcel of land not exceeding three acres in area for use as a homesite for a one-family residence, with landscaping, gardens and other such appurtenances, such parcel to have frontage upon a public road and to be essentially rectangular in shape with a length not more than three times its width. Such privilege or option shall be exercised by delivering written notice thereof to the grantee, or its successors. Upon such notice, the grantee, on behalf of itself and its successors, agrees to deliver forthwith a release of such parcel from this easement."

APPENDIX F

Restrictive agreement between private land owners and The Nature Conservancy to provide for the preservation of the Bantam River in Litchfield, Connecticut

"This Agreement . . . , by and between (list of owners) . . . , and *The Nature Conservancy*, . . . Witnesseth

Whereas, the parties hereto are owners of land adjacent to and abutting upon the Bantam River in said Town of Litchfield; and

Whereas, the banks of the Bantam River and the land adjacent thereto in the area where the properties of the parties hereto are situated are of rare natural beauty and their terrain, vegetation, and wildlife have not yet been spoiled by the activities of mankind; and

Whereas, the parties hereto are mindful of the dwindling number of regions where nature has been allowed to develop her own plan, uninfluenced and undisturbed by the activities of mankind; and

Whereas, the parties hereto are desirous of conserving this area, as nearly as may be practicable, in its present state in order to preserve its natural beauty for both this and future generations; and

Whereas, other owners of land adjacent to and abutting upon the Bantam River have entered, or it is contemplated that they will enter, into agreement with *The Nature Conservancy* containing covenants in whole or in part identical with or similar to those contained herein;

Now, Therefore, the parties hereto for and in consideration of the mutual covenants herein set forth, each on behalf of himself, his heirs, executors, administrators, successors, and assigns agree with the others and with their respective heirs, executors, administrators, successors, and assigns that the following shall be covenants running with so much of the land described beneath their respective names in the appendix attached hereto and hereby made a part hereof as lines within two hundred (200) feet of the nearer bank of said Bantam River bounding said property (or if said property is on both sides of said river, then within two hundred (200) feet of each of said banks), and that the same shall be enforceable by the parties hereto and each of them and by their respective heirs, executors, administrators, successors, and assigns, and any of them and by any other owners (and by the successors in title of such owners) of land adjacent to and abutting upon the Bantam River who have heretofore entered or hereafter may enter into covenants in whole or in part identical with or similar to those hereinafter contained.

No sewage, industrial waste, or other objectionable, or offensive material shall be dumped or discharged into said river upon, over, or from such land, in so far as the owner thereof can control the same nor shall said area be used for leaching or for any sewage disposal field;

No billboards or other outdoor advertising signs shall be erected thereon;

No topsoil shall be removed therefrom;

No commercial lumbering operations shall be conducted thereon;

No sand, gravel, or other minerals shall be excavated therefrom;

No pig pens, slaughter houses, or other structures for the conduct of activities that would be considered a nuisance if conducted in a residential area shall be erected thereon;

No trees shall be cut thereon unless dead, diseased, or decayed or for the better landscaping of the area;

No buildings of any description shall be erected thereon;

There shall be no dumping of refuse, nor burning of refuse thereon;

There shall be no hunting or trapping thereon;

There shall be no stripping of the land in such a way as to promote erosion thereof."



"Bogs harbor a distinctive group of plants that includes many members of the heath family. . . . Typical trees are tamarack and black spruce."



In 1955 severe floods struck the northeastern United States. Many lives were lost and millions of dollars of damage was done to property. In eastern Pennsylvania, hundreds of bridges were washed out along river courses that could not contain the billions of gallons of water that surged down them. When the water subsided, two bridges, of a type that was destroyed nearly everywhere else, were left standing. Both were located just below Cranberry Bog, a natural wetland area that had been permanently preserved by a national conservation agency, the Nature Conservancy, with the aid of local Pennsylvanians. Could it be that the recent floods on the West Coast and in the Midwest are partly a result of man's destruction of marshes, swamps, and bogs?

—William A. Niering

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FOR THE MUNICIPALITY A WETLANDS ORDINANCE*

After extensive study of existing local and state wetlands legislation, Peter L. Johnson, a project director at Open Space Institute, drafted the following ordinance as a model for communities whose laws may be inadequate to cope with the complex problems of marsh and watershed land-use. This sample ordinance has been reviewed and approved in essence by two outstanding attorneys in the field of conservation law: Irving Like of Babylon, N.Y., and Benjamin Levine, former counsel to the New Jersey Department of Conservation and Economic Development. Though Johnson's model is especially applicable to coastal or tidewater situations, its basic format should also prove useful to inland communities as well. The names of official agencies cited in the ordinance are those of New York State and should, of course, be replaced by names of agencies appropriate elsewhere.

Coastal and Interior Wetlands, Flood Plain and Drainage Legislation

A local law regulating the dredging, filling, deposition or removal of materials, diversion or obstruction of water flow, placement of structures and other uses in the water courses, coastal wetlands, tidal marshes, flood plain lands, watershed, water recharge areas and natural drainage systems in the Town of _____ and the requirement of permits therefore.

Be it enacted by the Town of _____, State of _____, as follows:

Section 1.0 Legislative Intent

1.0 The Town Board of _____ finds that rapid growth, the spread of development and increasing demands upon natural resources are encroaching upon, despoiling, polluting or eliminating many of its water courses, coastal wetlands, tidal marshes, flood plain lands, natural drainage systems, watersheds and water recharge areas and other natural resources and processes associated therewith which, if preserved and maintained in an undisturbed and natural condition, constitute important physical, social, esthetic, recreation and economic assets to existing and future residents of the Town.

1.1 It is the intent of the Town Board to protect the citizens of the Town of _____ by providing for the protection, preservation, proper maintenance and use of its water courses, coastal wetlands, tidal marshes, watersheds, water recharge areas and natural drainage systems in order to minimize their disturbance, prevent damage from erosion, turbidity or siltation, salt water intrusion, loss of fish, shellfish, or other beneficial marine organisms, aquatic wildlife and vegetation and the destruction of the natural habitat thereof, the danger of flood and storm tide damage and pollution, and to otherwise protect the quality of water courses, coastal wetlands, tidal waters, marshes, shorelines, watersheds and water recharge areas,

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underground water reserves, beaches and natural drainage systems for their conservation, economic, esthetic, recreation and other public uses and values and further to protect the Town's potable fresh water supplies from the dangers of drought, overdraft, pollution and misuse or mismanagement. Therefore, the Town Board declares that regulation of the water courses, coastal wetlands, tidal marshes, flood plain lands, watersheds, water recharge areas and natural drainage systems of _____ Town is essential to the health, safety, economic and general welfare of the people of _____ Town, and for their interest.

Section 2.0 Title

2.0 This local law shall be known and may be cited as the "Coastal and Interior Wetlands, Flood Plain and Drainage Law" of the Town of _____

Section 3.0 Definitions

3.0 The following terms, phrases, words and their derivatives shall have the meaning given herein:

- a) *Peak-lunar tides*—those excessively high tides or spring tides caused by lunar gravitational phenomena.
- b) *Tidal waters*—shall include all waters bordering on or within the Town boundaries subject to fluctuations in depth from storm, peak-lunar or normal tidal action and shall include but not be limited to all brackish and salt waters of streams, ponds, creeks, estuaries, bays, sounds, inlets and the ocean, and may include certain fresh waters.
- c) *Water courses*—all water bodies other than tidal waters, including fresh water streams, marshes, swamps, bogs, vernal ponds, ponds and lakes.
- d) *Coastal wetlands*—shall include all lands and submerged lands bordering on or within the Town boundaries which are covered by tidal waters permanently or intermittently from normal or peak-lunar tides.
- e) *Tidal marsh*—shall include those coastal wetlands inundated by tidal waters from normal tidal action, and/or peak-lunar tides, exhibiting salt-marsh peat at their undisturbed surface and upon which grow some or all of the following indigenous vegetation: Salt meadow grass (*Spartina patens*), spike grass (*Distichlis spicata*), black grass (*Juncus gerardi*), cordgrass (*Spartina alterniflora*), saltworts (*Salicornia* sp.), sea lavender (*Limonium carolinianum*), saltmarsh bulrushes (*Scirpus robustus* and *Scirpus paludosis* var. *Atlanticus*), sand spurrey (*Spergularia marina*), tall cordgrass (*Spartina pectinata*), high tide bush (*Iva frutescens* and *Iva baccarus*), cattails (*Typha angustifolia* and *Typha latifolia*), spike rush (*Eleocharis rostellata*), chairmaker's rush (*Scirpus americana*), bent grass (*Agrostis palustris*), and sweet grass (*Hierochloa odorata*).
- f) *Intertidal zone*—shall include those tidal marshes and coastal wetlands regularly covered and exposed by normal tidal water action; the area between mean low water and mean high water including the low marsh cordgrass (*Spartina alterniflora*).
- g) *Upland*—shall include all lands at elevations above the most land-ward edge of the tidal marsh and/or above peak-lunar tides or peak storm tide of record.
- h) *Coastal flood plain*—shall include all tidal waters and all those submerged lands, coastal wetlands, tidal marshes and contiguous uplands which are inundated regularly or intermittently from normal tidal cycles and/or peak-lunar and storm tides. The upland limit of peak storm tide and, hence, limit of the coastal flood plain shall be established at the upland U.S.C.G.S. contour representing the local maximum flood of record or maximum historical flood.
- i) *Natural drainage system*—shall consist of those uplands, flood plain lands and water courses, including coastal wetlands designated on the Official Map of _____ Town. Such lands and waters may include but not be limited to all uplands exhibiting 15% or greater slopes, all fresh, salt or brackish water, swamps, bogs, marshes, streams, vernal ponds, ponds, lakes and all lands within the coastal flood plain whether intermittently or permanently saturated or covered by ground, surface or tidal waters.
- j) *Watershed lands*—all land surface areas bounded peripherally by a water parting and draining ultimately to a particular water course. Such lands shall include all

surface water catchment areas or drainage basins from which the water courses are drawn via surface drainage.

k) *Water recharge areas*—all land surface areas which by nature of their surface and/or subsurface soil characteristics are determined to contribute to the replenishment of subsurface water supplies.

l) *U.S.C.G.S. contour*—those elevations established on contour maps of the U.S. Coast and Geodetic Survey.

m) *Material*—shall include but not be limited to soil, sand, gravel, clay, bog, peat, mud, debris and refuse or any other material organic or inorganic.

Section 4.0 Prohibited Acts

4.0 Except as hereinafter provided it shall be unlawful for any person without obtaining a written permit therefore issued upon the order of the Town Board to:

a) place, deposit or permit to be placed or deposited debris, fill or any materials including structures into, within or upon any tidal waters or other water courses, coastal wetlands, tidal marshes, coastal flood plain lands, watershed lands, water recharge area or any natural drainage system shown on the Official map of the Town of _____.

b) dig, dredge, or in any other way alter or remove any material from submerged lands, coastal wetlands, tidal marshes, coastal flood plain lands, watershed or recharge lands, natural drainage systems, tidal waters or other water courses designated on the Official Map of the Town of _____.

4.1 The deposition or removal of sand, gravel or any materials and construction of groins, docks, bulkheads, boat houses, dwellings, accessory buildings, roads or other improvements within the water courses, coastal flood plain, watershed and recharge lands, or natural drainage system shall be regulated by provisions of this law.

4.2 The deposition or removal of natural products of the water courses, tidal waters, coastal wetlands and submerged lands by commercial or recreational fishing, shellfishing, aquaculture, hunting or trapping operations shall be excepted from provisions of this law, where otherwise legally permitted.

Section 5.0 Permitted Acts

5.0 The acts set forth in Sections 4.0 and 4.1 are permissible if done pursuant to terms and conditions of a permit approved by the Town Board, Town Trustees, Conservation Advisory Council and obtained from the Town Clerk or pursuant to an approved and filed subdivision map or building permit carrying final site development approval by the Planning Board and approved by the Town Board.

5.1 The following operations and uses are permitted in the water courses, the coastal flood plain, watershed lands, water recharge area or a natural drainage system as a matter of right subject to provisions of sections 4.0:

a) Conservation of soil, vegetation, water, fish, shellfish and wildlife.

b) Outdoor recreation including play and sporting areas, field trials, nature study, hiking, horseback riding, swimming, skin diving, camping, boating, water skiing, trapping, hunting, fishing and shellfishing where otherwise legally permitted.

c) Operation of dams and other water control devices including temporary alteration or diversion of water levels or circulation for emergency, maintenance or aquaculture purposes.

d) Grazing, farming, nurseries, gardening and harvesting of crops.

e) Boat anchorage or mooring.

f) Uses accessory to residential or other permitted primary uses of adjoining lands or waters provided they are consistent with the intent and objectives of this law.

5.2 Upon the issue of a special permit for an exception to sections 4.0 or 4.1 and subject to such special conditions or safeguards as the Town Board may deem necessary to fulfill the intent and objectives of this law, the following uses and operations are permitted:

a) Docks, bulkheads, boat launching or landing sites and marinas.

b) Temporary storage of materials.

c) Appropriate municipal use such as parks, recreation, wildlife sanctuaries, and accessory uses such as concessions.

d) Commercial or private recreation facilities consistent with this law as determined by the Town Board.

e) Dams and other water control devices, dredging or diversion of water levels or circulation or changes in water courses to improve hazardous navigation conditions, or for the improvement of fish, shellfish or wildlife habitat, recreation facilities or drainage improvements deemed to be consistent with the intent and objectives of this law by the Town Board.

f) Driveways and roads where alternative means of access are proven to be impractical in the considered judgment of the Town Board.

5.3 All uses and operations permitted or approved by special permit shall be conducted in such a manner as will cause least possible damage and encroachment or interference with natural resources and natural processes within the water courses, coastal flood plain, watershed and recharge areas or a natural drainage system.

5.4 Provided the Planning Board concurs, that portion of any single lot or subdivision in a coastal flood plain, watershed, recharge lands or natural drainage system may be used in calculating the area and yard requirements for the zoning district in which the remainder of the lot or subdivision is situated.

5.5 The valuation placed on coastal flood plain, watershed lands, water recharge areas or natural drainage systems for purposes of real estate taxation shall take into account and be limited by the limitation on future use of such land provided:

a) The landowner grants to the Town a permanent scenic or conservation easement to run with the land. Such easement shall not necessarily include public access, but shall give to the Town all development and management rights upon the land subject to the easement. The value of such easement shall be a legal income tax deduction subject to Internal Revenue Code, B. Statutes and Rulings Section 170—Charitable, etc., Contributions and Gifts.

Section 6.0 Permit Procedure

6.0 All applicants for a permit to do any of the acts permitted or prohibited by Sections 4 and 5 shall present an original and six copies of the permit application together with other required information to the Town Clerk. All applications and copies thereof must be accompanied by or include the following information:

a) Name and address of applicant and applicant's agent if any and whether applicant is owner, lessee, licensee, etc. If applicant is not owner, the written consent of the owner, duly acknowledged, must be attached.

b) Purpose of proposed removal or deposition operations, use or activity.

c) Amount of material proposed to be removed or deposited or type of structure or proposed type of use.

d) Description of the area in which removal, deposition or use is proposed; the description shall be by bearing distance and based upon the Lambert Projection. North and east coordinates of the starting point shall be given.

e) Depth to which removal or deposition operations are proposed and angle of repose of all slopes including deposited materials and sides of channels or excavations resulting from removal operations.

f) Manner in which material will be removed or deposited, structure installed or use carried out.

6.1 Permit application shall be accompanied by:

a) A survey and topographical map, with contours shown at one foot intervals and the area of removal, deposition, use or construction indicated.

b) All maps shall be certified by a registered land surveyor or Professional Engineer, both licensed in the State of _____.

c) Survey and topographical map shall show soundings, depth or height of proposed removal and deposition area. The horizontal control of survey shall be based upon the Lambert Projection. The vertical control for elevation and soundings shall be based upon U.S.C. and G.S. and/or U.S. Geological Survey datum.

d) The names and addresses of all owners of lands contiguous to lands and waters where proposed operations will take place.

e) A filing fee representing no more than five percent of the estimated cost of the proposed operation as designated by the Town Board.

6.2 This local law does not obviate the necessity for the applicant to obtain the assent or a permit required by any other agency before proceeding with operations under an approved Town Board permit. Approval or permits which may be required by the Town Board of Trustees, State Water Resources Commission, Department of the Army or others, is solely the responsibility of the applicant. No operations shall be initiated by the applicant until such other permits as may be required are issued.

6.3 All applications for building permits, filed subdivision maps or any development within the water courses, coastal flood plain, watershed lands, water recharge areas or a natural drainage system shall be reviewed by the Town Trustees, Town Conservation Advisory Council and Natural Resources Commissioner and shall receive those agencies' approval before Planning Board approval may be issued. When available the Planning Board shall seek the advice and consultation of the State Conservation Department, U.S. Department of the Interior and/or the County Regional Planning Agency in developing its recommendations concerning an application for a building permit within any water course, coastal flood plain, watershed lands, water recharge area, or natural drainage system of the Town. The Planning Board's final recommendations thereon to the Town Board shall be in writing.

Section 7.0 Administration of Permit Application

7.0 The Town Clerk shall retain the original permit application for his files and distribute one copy each to the Town Board, Town Trustees, Town Engineer, Planning Board, Conservation Advisory Council and Natural Resources Commission. Each of those agencies shall study the permit application and forward a report and recommendation thereon to the Conservation Advisory Council within thirty (30) days, indicating approval, disapproval or approval with conditions. Recommended conditions or reasons for disapproval shall be itemized and explained in writing.

7.1 The Conservation Advisory Council shall review all comments and recommendations pertaining to the permit application and provide a written report to the Town Board as its final recommendation on the application within fourteen (14) days of receipt of recommendations of other agencies. Upon prior reasonable public notice published in the official newspaper of the Town, the Town Board shall hold a public hearing on the permit application. The Town Board shall, after required public hearing, then render a decision to deny, approve or approve with conditions the permit application. In rendering a decision of approval, approval with conditions or denial of a permit, the Town Board shall state in writing its findings of fact and conclusions. The decision shall be transmitted to the Town Clerk who will advise the applicant of such decision by transmitting a copy of the permit application to applicant with the decision and conditions, if any, imposed by the Town Board attached.

7.2 If permit application is denied or approved:

- a) Any decision of the Town Board regarding a permit application shall be judicially reviewable.
- b) Any member of the public may sue to challenge the approval and issuance of a permit.
- c) If permit is denied or approved with conditions unacceptable to the applicant after public hearing, applicant may appeal to the (appropriate court).

7.3 Based upon proceedings and decision of the court in the event a taking is declared, the Town may, within the time specified by the Court, elect to:

- a) Institute condemnation proceedings to acquire the applicant's land in fee by purchase at fair market value;
- b) Approve permit application with lesser restrictions or conditions;
- c) Invalidate all conditions and the application of this law to plaintiff's land and grant a permit without conditions.

7.4 The permit applicant or his agent proceeding with operations approved shall carry on his person or have readily available the approved permit and show same to any agency or agent of the Town of _____ whenever requested.

7.5 Operations conducted under permit shall be open to inspection at any time by any agency or agent of _____Town.

Section 8.0 Compliance With Conditions

8.0 The permit applicant upon approval of permit shall file with the Town Clerk a performance bond, if required, in an amount and with sureties and in a form approved by the Town Board:

- a) The bond and sureties shall be conditioned on compliance with all provisions of this local law and conditions imposed on permit approval.
- b) Applicant shall certify that he has public liability insurance against liability which might result from proposed operations, or use covering any and all damage which might occur within three years of completion of such operations.
- c) Amount of liability insurance coverage shall be a minimum of five hundred thousand (\$500,000.00) dollars for all accidents resulting in bodily injury or death, and one hundred thousand (\$100,000.00) dollars for property damage.
- d) Applicant shall also submit to the Town Clerk an affidavit which indemnifies and saves harmless the Town or any agency or agent thereof from any claims arising out of or connected with operations under the permit and from all acts, omissions, commissions, or negligence on the part of the applicant, his agents or employees.
- e) In the case of removal, deposition, placement of structures, other operations or uses permitted within the water courses, coastal flood plain, watershed lands, water recharge areas or a natural drainage system, the Town Board shall reserve the right to require payments to the Town in an amount and in such manner as the Town Board shall direct.
- f) The Town Board shall reserve the right to require a permit or license for any operations or uses permitted in the water courses, flood plain lands, watershed lands, water recharge areas or natural drainage systems of the Town.

Section 9.0 Penalties and Corrective Action

9.0 Any person, firm, corporation or entity found violating any provision of this local law or conditions imposed by the Town Board upon an approved permit shall be served with a written notice at the direction of the Town Board stating the nature of the violation and providing a specified time within which the violation shall cease and satisfactory corrective action taken by the violator:

- a) Any person, firm, corporation or entity violating this local law shall be guilty of an offense, and upon conviction thereof, be punishable by fine or imprisonment, or both. Fines may be up to one thousand dollars (\$1,000.00) and imprisonment may be for thirty (30) days or less.
- b) Any person, firm, corporation or entity who shall continue such violation beyond the time limit specified by the Town Board shall be guilty of another offense, and upon conviction thereof, be fined in an amount not to exceed one thousand dollars (\$1,000.00) for each offense or imprisoned thirty (30) days or both.
- c) Each day of such violation shall constitute a separate offense under this law.
- d) In the event any person, firm, corporation or entity shall continue any violation beyond the time limit specified by the Town Board, the Town Board shall direct the Town Attorney to apply to the Supreme Court in the _____ Judicial District for an order directing the violation be corrected or removed, and that all costs and expenses incurred by the Town of _____ in connection with proceedings, including the actual costs of correction or removal shall be assessed against the offender.
- e) Any person, firm, corporation or entity violating the provisions of this local law shall become liable to the Town for any expense or loss or damage occasioned the Town by reason of such violation.

Section 10.0 Existing or Prior Conditions

10.0 Any structures, dwellings, construction or operations existing within a water course, flood plain lands, watershed lands, water recharge area or a natural drainage system as designated on the Official Map of the Town prior to the effective date of this ordinance shall be exempt from this law and permitted to continue provided that:

- a) No new construction, structures, dwellings or operations will be permitted after the effective date of this law, except by permit as provided herein.
- b) Where damage or hazardous conditions exist, the landowner may be required by the Town Board to repair such damage or remedy such hazardous conditions as the Town Board may direct.

Section 11.0 Validity

11.0 All ordinances and local laws or parts of ordinances and local laws in conflict herewith are hereby repealed.

11.1 The invalidity of any word, clause, sentence, section, part or provision of this local law shall not affect the validity of any other part of this local law which can be given effect without such invalid part or parts.

Section 12.0 Effective Date

This local law is enacted under provisions of [New York State General Municipal Law, Sections 239, 247, 261, 263 and New York State Town Law, Section 277]. This local law shall take effect immediately.

What would the world be, once bereft
Of wet and of wildness? Let them be left,
O let them be left, wildness and wet:
Long live the weeds and the wilderness yet.

—from *"Inversnaid"*

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Connecticut Arboretum Bulletins

- No. 6. Check List of Woody Plants growing in the Connecticut Arboretum and Guide to the Arboretum. Richard H. Goodwin, Katherine H. Heinig and Kaleb P. Jansson. pp. 32. 1950. .35
- No. 7. The Connecticut Arboretum: Its History and the Establishment of the Natural Area. pp. 16. 1952. .15
- No. 8. The Connecticut Arboretum: The Mamacoke Acquisition and our Research Program. 1955. (Out of print).
- No. 9. Six points of Especial Botanical Interest in Connecticut. pp. 32. 1956. The areas described are the Barn Island Marshes, the Connecticut Arboretum, the North Haven Sand Plains, Catlin's Wood, the Cathedral Pines, and the Bigelow Pond Hemlocks. .40
- No. 10. Birds of the Connecticut Arboretum and the Connecticut College Campus, pp. 24. 1958. An annotated list with seasonal records and an account of the breeding bird census program. .40
- No. 11. A Roadside Crisis: the Use and Abuse of Herbicides. pp. 16. 1959. A proposed program for use of herbicides on town roads, to avoid present destructive practices. .10
- No. 12. Connecticut's Coastal Marshes: A Vanishing Resource. pp. 36. 1961. Testimony of various authorities as to the value of our tidal marshes and a suggested action program. 2nd printing with supplement 1966. .40
- No. 13. What's Happening Along Our Roadsides? pp. 24, 1962. Roadside spray practices in the National Forests; Recommended practices for Connecticut; Survey of what is actually happening. .25
- No. 14. Creating New Landscapes with Herbicides—A Homeowner's Guide. pp. 30. 1963. A how-to-do-it handbook describing the formulations and techniques to be used in eliminating unwanted plants such as poison ivy. The use of herbicides in naturalistic landscaping, wildlife and woodlot management are included. 1.00
- No. 15. The Flora of the Connecticut Arboretum, pp. 64. 1966. Includes annotated checklist of over 850 species and also article on vegetation of Arboretum. 1.00
- No. 16. A Guided Tour of The Connecticut Arboretum. pp. 32. 1967. A self-guided walk through a diversity of habitats. .50
- No. 17. Preserving our Freshwater Wetlands. pp. 52. 1970. Reprints of a series of articles on why this is important and how it can be done. 1.00