

of nature. The values which flow from these zones to human society are equally worthy of attention. Unfortunately, neither estuarine knowledge nor awareness of estuarine values is widespread among the people of the United States. Much is known by a few, a little is known by some, and almost nothing is known on these subjects by the vast majority of our citizens.

A noteworthy fact that must be emphasized is that estuaries are integral parts of the basins of rivers which empty into them. The profound effect on estuaries of man-caused changes in the water cycle and the land-water relationships in those basins is readily apparent. Even to the handful of biological and physical scientists who have spent lifetimes studying them, estuarine zones hold many secrets which are locked up in the intricate relationships and functions of their waters, soils, plants, and animals. In fact, the preponderant national ignorance of these matters is one of the main roots of the problem.

The question, "What good are coastal wetlands and estuarine zones?" is routinely asked by those whose interests would destroy them, and lies uncomfortably in the minds of many who sense in this destruction a threat to valued resources.

Estuarine areas rank among the most naturally fertile areas for finfish and shellfish. It is axiomatic that a Nation facing a projected increase in the population to about 245 million by 1980 and to 331 million by the year 2000 will require an increased protein harvest, from the sea as well as from our agricultural lands.

But even under the present economic structure, the utilization and dollar value of the domestic commercial seafood catch from our coastal waters are impressive. In 1963, the weight of the catch and the amount paid to fishermen (ex-vessel value) were, in round numbers: for the Atlantic Coast--2.2 billion pounds, valued at \$139 million; for the Gulf Coast--1.4 billion pounds, valued at \$99 million; for the Pacific Coast (exclusive of Hawaii)--1.1 billion pounds, valued at \$124 million; and for all three coastal areas--4.7 billion pounds, with an ex-vessel value of \$362 million. Based on these 1963 totals, an estimated 65 to 75 percent of both the catch and the value was estuarine dependent.

Numerous finfish and shellfish species which are estuarine dependent contribute to the commercial marine catch. Many of the same species also are well represented in the yearly salt-water sport fishing catch. Marine sport fishing is, in fact, a most important recreational activity in the United States. Our 1960 National Survey of Fishing and Hunting uncovered these facts: Salt-water fishermen in the United States spent more than 80.6 million days

and over \$626 million in pursuit of their sport. These expenditures of time and money were, respectively, about 17 and 23 percent of the totals for all sport fishing (fresh- and salt-water) during 1960.

Is the fertility of our estuarine zones a reality? Does their productivity warrant their conservation in competition with other sources of food production? If so, why are they so fertile and productive?

A few comparisons will clearly show how productive the estuarine zones really are. Consider for a moment the gross, primary productive capacity of the three major groups of land and water environments in the world, expressed as dry weight of organic matter produced per acre per year. The least productive group, land deserts and deep oceans, produce only at a rate ranging in the hundreds of pounds per acre. The intermediate group of grasslands, forests, eutropic lakes (shallow lakes, rich in nutrients), and ordinary agricultural lands produce at a rate of thousands of pounds per acre. The most productive group, which includes estuaries, deltas, coral reefs, and intensively-managed agricultural lands (sugar cane, rice), are capable of producing not hundreds or thousands but tens of thousands of pounds of organic matter per acre per year.

Reasons for the high productivity of estuarine zones are complicated and only partly known. The underlying causes seem to be: first, that estuarine waters are endowed with a semi-closed system of circulation that provides efficient nutrient exchange. Vertical mixing of waters due to differences in salinity and temperature aided by shallow depths, sluggish outflow, and work of the wind, circulates the nutrients among the organisms, the water body, and sediments, thus lessening the chances of their being swept out to sea or locked up in the bottom.

Second, estuarine organisms and productivity are favored with a continual replenishment of nutrient supply, both by runoff from the land and incursion from the depths of the sea. The tides not only distribute this nutrient supply throughout the zone, but also flush away the waste products of all life therein.

The third major reason for high estuarine productivity is its essentially year-round, highly integrated nature. There are three production elements which interact in the food-making machinery of estuarine systems: marsh grasses, the "mud algae" of the sediments on the banks and bars in the zone between high and low tides, and the microscopic plant life (phytoplankton) of the water. Among them they fully exploit the productive capacity of every niche of the zone at all seasons.

Where did the well-entrenched and widely-held belief that estuaries and marshes are wastelands originate?

The high output of organic matter in estuarine zones is, to be sure, not the same as the "yield to man." An acre of edible wheat or corn still provides more human food than an acre of estuarine "vegetables and meats." But we must remember these facts: though largely not directly usable by man, the great quantity of primary organic matter produced in estuaries and marshes is indirectly very important to him in fishery production and may be equally or more important to him in other ways yet to be discovered. Also, the marine crop we have been describing is not directly comparable to agricultural yields. The usable fish crop which can be attained under known management techniques may be only about three percent of the primary organic production. This is small compared to the best conversions known under intensively managed animal production; the cardinal point is that this primary organic production is the basis for most of the existing near-shore production of sea foods and ocean products.

And consider the recreational opportunities afforded by estuaries. Millions of us hunt, fish, camp, boat, swim, and click camera shutters. Many more millions derive immeasurable benefit by simply looking at the natural water and marsh landscape. The great scientific and educational values of estuaries and their environs are less widely appreciated although, no doubt, will in time be more fully enjoyed.

The Problems

For 300 years and more the American landscape and waterscape have been subjected to continuing development and change. In the 17th and 18th centuries, the process of change was slow and hardly noticeable. In the 19th, the pace quickened, and in the 20th century, especially during the past two decades, it has speeded to a headlong gallop. The changes have been profound as well as fast moving.

Inspection of a cultural map of the United States soon verifies the fact that much of our population, nearly 70 percent of which resides in urban areas, is concentrated along our coastlines in a belt 50 to 100 miles wide, which, of course, also includes all our estuarine zones.

Population pressures and the accompanying development of urban civilization are thus a natural threat to estuaries. Very few of the major estuaries are without centers of population nearby or along their shores, and many of them are the sites of most of our large cities.

In the race to utilize our natural resources, industrialize our economy, expand our agriculture, and provide living space for our people, estuaries and other coastal geography, including wetlands and their related values, have taken severe punishment. Unfortunately,

the pattern of use in estuarine zones has not been marked by the exercise of considered judgment, due regard for cause and effect relationships, or the application of firm knowledge for orderly development in the public interest.

It is often forgotten that estuaries and wetlands were created and are maintained by powerful forces--sun, wind and tide--the gamut of natural forces. We fill and destroy the marshes and thereby reduce the tidal scour of the channels so that the balance between these forces and siltation is upset.

We cut off and divert the fresh-water flows, compounding the filling. Marshes once filled and destroyed cannot dissipate the power of the sea within their spongy, shock-absorbing expanses. The tide and the waves can only pound against the communities and industrial developments which stand on the fill where the marshes once were.

Thus, continued encroachment upon our estuarine zones means continued high cost, year after year, to build sea walls, hurricane barriers, dikes and other protective devices. Those devices, in turn, create their own damages to our fisheries, to our wildlife, and to our natural coastline, scenic, and recreation areas.

The prime or major types of practices instituted by man which affect estuaries and coastal wetlands are relatively few in number, but generally adverse in effect. These are dredging and filling; drainage and pollution; and control of water -- regulation and storage of rivers, channelization and harbor development of bays and estuaries, and regulation of the tidal flow of the sea.

These basic practices frequently stimulate follow-up practices which also are usually detrimental in effect.

Dredging and filling projects - These are usually undertaken for the primary purpose of constructing, improving and maintaining navigation channels in bays, estuaries, and the larger rivers. Millions of cubic yards of material must be removed from these channels each year to prevent them from becoming filled in by silt and organic debris newly brought down from upstream, or redistributed by tides. Unfortunately, the peripheral wetlands and shallow waters shoreward of these navigation channels are the closest, easiest, and cheapest places to deposit the dredged material. Over time, great expanses of land are required for deposit of spoil from such dredging. Thus the spoil from construction and maintenance of channel dredging projects is also used to cover up marshlands and make them suitable for individual and urban development which means permanent loss of the marsh.

There are navigation projects, continuous through the years, in Delaware River and Bay; along the Long Island, New Jersey shores; in the harbor of Savannah, Georgia; at the mouth of the Mississippi River (known as the Mississippi River - Gulf Outlet Project); in the inter-coastal waterway along the Atlantic and Gulf Coasts; and in San Francisco Bay and estuary, to name a few.

There are other types of dredge-and-fill projects. New land is being created in shallow coastal waters by dredging fill from adjacent water bottoms. Also there are hurricane-barrier projects proposed or underway, for example, in Narragansett Bay in Rhode Island and Delaware Bay in New Jersey and Delaware; and salt-water barriers proposed at Lake Ponchartrain in Louisiana and at San Francisco Bay in California.

Hurricane barriers are intended to protect industrial and other urban developments against the fury of the sea and wind during hurricanes. Salt-water barriers are designed to reduce the concentration of salt in the lower reaches of major rivers which adjoin urban centers so that the fresh water may be used by cities and industry. Land reclamation projects, on an appreciable scale, have caused thousands of acres of coastal marshes to be filled for agriculture, industry, recreational sites and home sites.

Other similar practices include the use of wetlands and estuarine shallows as waste disposal sites, trash dumps and sanitary land fills, and by the removal of the productive marsh overburden to mine gravel deposits beneath.

Here are a few statistics and examples of dredging and filling: For our tidal wetlands along our North Atlantic Coast, from Maine to Delaware, about 45,000 acres were destroyed in the 10-year period 1954 - 1963, according to surveys made by the Bureau of Sport Fisheries and Wildlife. During the last five of those years, some 34 percent of the marshes have been lost to deposition of spoil; about 27 percent to housing developments; another 15 percent to certain types of recreational developments (parks, beaches, marinas); an additional 10 percent to construction of bridges, roads, parking areas and airports; some 7 percent to industrial sites; approximately 6 percent to waste disposal area; and the final one percent to a variety of other causes.

The San Francisco Bay shoreline for many years has been subject to landfill operations instigated by population and industrial pressures upon a limited land area together with the requirements for maintaining navigation channels in the Bay and in the lower Sacramento and San Joaquin Rivers which empty into it. The problem of finding space for the dredged spoil is a perpetual one. Some eight to ten million cubic yards of sediment from the Sacramento and San Joaquin Rivers are deposited in the bay annually.

Less prevalent than dredging and filling projects, but nevertheless important destroyers of estuarine zones, are other projects and influences of man.

Drainage projects - Coastal wetlands are drained for several reasons, among which are mosquito control and the creation of new agricultural cropland. Destructive ditching and drainage of marshes usually can be avoided in mosquito control. Increased cropland can be provided through irrigation in the arid interior and production can be increased on existing croplands.

The Everglades in southern Florida is an example of a drainage problem. It is not essentially an estuarine area; rather it is a vast wetland threatened by man's unstudied developments for flood control and allied purposes. Solutions are actively being sought, but the problem is complex and no easy solutions have appeared.

Pollution - The scale on which our waterways, estuaries, and oceans are used as septic tanks for municipalities and as repositories of all manner of industrial and chemical wastes, including pesticide residues, is a national shame. The deleterious and outright destructive effect of this use of our coastal waters is deplorable, but available remedies are costly. The public must be made aware of the need for control, the justification of the costs, and the need for concerted effort to develop better and cheaper remedies.

Control of fresh and sea water flow - Thousands of dams, large and small, have been constructed in the Nation's river basins across streams whose flow ultimately empties into estuaries and coastal wetlands. The net effect of these practices on the productivity and physical characteristics of estuaries has not always been favorable. Reduction of natural fresh water outflow with its disruption of salinity and pollutant dilution, nutrient exchanges, sedimentation and current patterns usually has damaged the estuarine environment and reduced the natural maintenance of beaches.

What agencies are responsible for this host of activities which alter our coastlines so profoundly? There are many - Federal, State, and local government agencies, as well as private enterprise. The chief Federal agency is, of course, the U. S. Army Corps of Engineers, which since the early 1800's has been assigned by the Congress the job of undertaking and supervising flood control, navigation and other projects throughout the navigable waters of the United States.

Permit me to make one thing crystal clear: This paper is not an argument for halting the wheels of progress, per se. The activities which destroy estuaries and wetlands are not undertaken with that willful purpose in mind. They are undertaken to serve useful purposes.

We cannot turn back the clock to 1620, or 1870 or even 1940. But I think we can ask some penetrating and thought-provoking questions about selecting means and methods to achieve and enjoy progress. There must be a better way. We are going to have to find another way. We're running out of real estate, and water, and resources. The question is: "What next?"

The Progress

There isn't time to review more than a little of what is being done now to help conserve estuaries and wetlands. It is important at this point to say something about the key types of activities because plans for future action must be built on present action - and must, in fact, improve on it.

Under the provisions of the Fish and Wildlife Coordination Act, the Fish and Wildlife Service is authorized to investigate proposed Federal or Federally-licensed water development projects to evaluate the probable effects of the projects on fish and wildlife resources. Also, the Service recommends whatever is deemed necessary within the limits of reasonability to conserve the resources, including measures which will lessen damages or enhance fish and wildlife values.

Each year, our Bureau studies hundreds of such projects throughout the country, and in conjunction with State conservation departments, recommends fish and wildlife measures for incorporation in project plans in its reports to the concerned planning agencies. The planning agencies are obligated to consider these recommendations, but they are not required to accept and implement them. The Federal planning agencies are required to include our reports as an integral part of any feasibility reports. We, therefore, perform an advisory service but exercise no veto power.

In the two decades during which we have been busily engaged in implementing the Fish and Wildlife Coordination Act, numerous recommendations have been put into effect by the planning agencies. A case in point is the Mississippi River - Gulf Outlet Project. However, many of the recommendations are not accepted, for one reason or another.

Most of the water resource agencies with which we deal are Federal planning and licensing agencies. The two largest planning agencies are the U. S. Army Corps of Engineers, and the Bureau of Reclamation of the Department of the Interior. A major project licensing agency is the Federal Power Commission which issues permits and licenses to non-Federal organizations to construct hydroelectric power projects involving the navigable waters and public lands of the United States. Another is the Corps of Engineers which controls developments affecting navigation through a permit system. This function of the Corps frequently involves a variety of activities affecting estuaries, such as the

construction of bridges, dams, dikes, and causeways across waterways. The construction of wharves, piers, dolphins, booms, weirs, breakwaters, bulkheads, jetties, and the excavation and filling of navigable waterways all come under Federal scrutiny and review through the Corps' Navigation Permit system and the requirements of the Fish and Wildlife Coordination Act. Every year, thousands of applications for permits are received by the Corps and reviewed by us.

The Fish and Wildlife Service has endeavored for many years to gain adequate consideration of fish and wildlife resources within the permit system of the Corps of Engineers. In our reports on these applications, we have many times recommended to the Corps that it either deny a permit or, prior to granting it, require modification of the plans to minimize damage to fish and wildlife resources. Only a relatively small number of these recommendations have been accepted.

The Corps of Engineers maintains that the decision as to whether a permit should be issued must rest primarily on the effect of the proposed work on navigation. The Department of the Interior contends that both the Fish and Wildlife Coordination Act and its legislative history authorize and direct the Corps to consider fish and wildlife equally with navigation in matters of permit issuance. One of the main purposes in amending the Act in 1958 was, in fact, to provide this authority. The issue long has been under negotiation with the Department of the Army.

In a few States, we have been encouraged by efforts to preserve coastal wetlands through legislation. Broadly speaking, this legislation has been designed in some measure to protect the public interest in wetland resource values, particularly in the case of areas not presently in State or Federal ownership. The bright spots in the picture are the States of Massachusetts, Rhode Island, and New York in the east, and California in the west. Several others, including New Jersey and Delaware, have been acquiring wetlands for several years, thus preserving them for an indefinite period.

Effective October 1, 1959, New York State's "Long Island Wetlands Bill" provides for cooperative agreement between the State and local governments, with provisions for both technical and financial assistance, for the purpose of preserving and maintaining wetlands owned by a Town or County. This was one of the early legislative efforts on behalf of coastal wetland preservation. The Act was amended, effective May 25, 1965, also to include villages within those jurisdictions eligible for entering into cooperative agreements.

Effective May 22, 1963, section 27A was added to Chapter 130 of the General Law of Massachusetts. In effect, this law requires that various local and State agencies be properly notified of intention to dredge or fill wetlands bordering on coastal waters, in order to protect marine fishery resources (and incidentally, many wildlife resources).

As was anticipated, test of the law has resulted in a recent Massachusetts Supreme Court decision in the case of Commissioner of Natural Resources (and another), vs. S. Volpe and Co., Inc., which involved the filling of Broad Marsh by the defendant. In essence, the case has been sent back to the lower courts for additional evidence, not as to the value of the marsh or the validity of the law, but on the unargued points related to the question: "Is the defendant the uncompensated victim of a taking without compensation?" Apparently, the outcome is dependent upon further findings as to what other uses the wetlands can be put, and possibly other considerations. As many of you know, legal questions regarding riparian rights and the uses of water comprise a very complicated field. The Massachusetts legislature presently is trying to resolve this foregoing issue by considering a bill, H.R. 3486, which would provide funds for payment to owners of wetlands who are deprived full use of their properties. As you can visualize, a far-reaching decision is at stake here.

The State of Rhode Island, in an act approved May 19, 1965, has established a system for coastal wetlands zoning. The Director (Department of Agriculture and Conservation) has been given authority to designate, following public hearing and proper notification thereof to all owners of record, such wetlands as deemed necessary to protect the purity and integrity of the coastal wetlands of the State. The latter are to include values related to public health, marine fisheries, wildlife, and coastal protection from natural disasters related to storms, floods, and so on. A section of the law provides for the recovery of damages on the part of wetland owners who suffer damages as a result of this zoning.

California's McAteer-Petris Act, approved this past July 12, recognizes San Francisco Bay as the most valuable single natural resource of the entire region, and establishes a San Francisco Bay Conservation and Development Commission to prepare a comprehensive and enforceable plan which protects the resources, while allowing development.

The 27-member Commission, which includes the Administrator of the State's Resources Agency, is to be composed of local, State, and Federal agency representatives, and also includes seven members from the general public. Prior to the fifth legislative day of the 1969 Regular Session of the Legislature, the Commission must file a final report with the Governor and Legislature.

During the period of study, the Commission is empowered to issue or deny permits, after public hearing, for any proposed project that involves dredging or filling practices. In essence, the Commission's authority embraces the entire San Francisco Bay area, except for marshland, tidelands, and submerged lands which are not subject to tidal action.

Also of interest is the fact that the California Act provides for the appointment of a 20-member advisory committee to the Commission, among which at least one biologist must be included. The Commission is scheduled for termination on the 90th day after final adjournment of the 1969 Regular Session of the California Legislature. The Act is far-reaching, and may well serve as a guide to other much-needed comprehensive studies of our coastal wetlands and estuaries.

All these actions are the result of an awakening public - a public awakening to their stake in coastal wetlands and estuaries. But much more needs to be done in all quarters, both private and public.

The Future

And what of the future? I believe the National crisis in preservation of coastal wetlands and estuaries must be resolved along four main courses: education, research, legislation, and coordination.

Most of us here are involved to some degree in educational activities related to natural, renewable resources. The needs for public conservation education are tremendous, while the fulfillment of these needs still is sadly lacking. Many conservation organizations must place emphasis--now--on the values of coastal wetlands and estuaries. An informed public is absolutely essential to the solution of this problem.

However, first-class educational efforts must depend upon the results of research--good solid research. Many dedicated workers have made possible the foundation upon which we stand today on behalf of these estuarine zones. But as the total understanding lies far beyond us, we must support all efforts to unravel the ecological relationships of these natural areas, and the effects of a changing environment upon them. Many local, State, and Federal research projects are being oriented toward the estuarine zones. The recent Water Resources Research Act already has resulted in several projects in estuarine study. Support these efforts! Encourage young biologists to enter this increasingly important field!

And legislation remains a necessity to enable actions on behalf of the public good, over the longest period of time. As we cited earlier, the legislative area is full of changes, and excitement, and ponderous problems. But consider the fact that the legislation we discussed has all occurred, or been altered, or is being tested now--in 1965. A more timely subject could not have been chosen for this convention.

But legislation per se is not the total answer, either, because only coordination can bring together the diverse forces of man which determine the fate of our estuarine zones. The meshing together of programs and competing interests is an art, not a science. It is an action that must be faced daily in our business, and in many of yours as well. But coordination is part of the workings of a democracy. Coordination must allow the consideration of many interests within the single-purpose projects and programs of any group or agency. Coordination need not, however, become a diluent to meaningful efforts in natural resource management and development.

Whether we like it or not, "special interests" play a significant part in the enactment and application of the law, and in coordination. In fact, we conservationists belong to a special interest group. Our motivation is not selfish, but on behalf of a society which can live within its natural environment without destroying it.

The problems surrounding the wise use of our coastal wetlands and estuaries are immense, and are closely intertwined with the activities of man, both within estuarine zones and in the watersheds leading to them. But the immensity of the problems should not lessen our efforts to solve them. We must accelerate, through every means at our command, the focusing of the Nation's attention upon our estuarine zones, the values they possess, and finally upon the fact that without drastic action, buttressed by public understanding, our estuaries will shortly have disappeared.

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