5-1972

Saltmarsh Ecology and Resource Protection

Gerard Desire Blais Jr.
University of Rhode Island

SALTMARSH ECOLOGY AND RESOURCE PROTECTION

Gerard Desire Blais, Jr.

A paper submitted in partial fulfillment of the requirements for MAF 650 (Seminar) and the degree of Master of Marine Affairs at the University of Rhode Island.

Kingston, Rhode Island

May, 1972

The late Paul T. Welch, noted hydrobiologist, once wrote, "the line of demarcation between the land and water is definite or indefinite depending on a number of natural circumstances." (1.) When applied to the ecology of the salt marsh and the problems of its use and development, this quotation becomes a tragic understatement of the issue.

Ignorance is killing the marshlands. A panoramic lack of conservation education has produced a populace largely unaware of the value of marshland resources or measures for their protection. In a relentless era of ecological abuse, wetlands and salt marshes rank with endangered animal species in the quantitative loss culminating in extinction. Challenged continually by the relentless sea and exploited by unsound attempts at development, management, or even conservation (!), the efficiency of the marshlands is decreasing with each successive invasion. There is a demonstrated reduction in biological productivity, flood control, and water quality in areas where dredging, draining, and filling of marshes has taken place. In several areas of the East coast, long settled and filled in, such as the western end of Long Island and the East River, the social costs resulting from marshland destruction amount to many times the funds required for their purchase, maintenance and protection. "It is now assumed by most people who

bother to think of it at all that marshes are valueless at best. Less hostile but more dangerous opinion simply considers them land, unusable in its present condition, the sooner filled the better." (2.)

The priorities of the saltmarsh are widespread in origin. While internal problems are extensive and cut across many scientific areas, the external issues, largely sociological, must also receive attention. It is in this area that the politico-economic future of the saltmarsh is decided (albeit often unknowingly) by persons having little or no contact with the coastal zone.

With a continuing increase in population, the United States is experiencing a land problem. This is far removed from being a shortage; it is rather a use and development crisis. Population density is higher for both coasts than in the middle of America, largely due to earlier colonization and receipt of immigrants. Farmland and coastland continues to disappear on both coasts as communities spring up. The trend is particularly acute for shoreline property as it is used for residential purposes and commercial expansion.

Esthetics and philosophy are also involved in the increasing commercial development of the wetlands. For the urban resident as well as the suburbanite, the sea has long been a scenic and recreational outlet. This urge leads increasing numbers of people to build, rent, or utilize shoreline property for extended occupancy.

> ...the nation faces a new order of social problems, including for the first time in history a serious concern for the creative uses of leisure available to our people. Today there is a growing realization that recreation is a full partner in water use;one that, with associated services represents a multimillion dollar industry with substantial prospects for future growth. (3.)

In a 1962 report (4.) the Federal Outdoor Recreation Resources Commission found recreation in the United States strongly associated with water--to sit by: to walk alongside; to swim; to fish and to boat in. Marshes have been and continue to be sacrificed to provide physical facilities for the satisfaction of these goals for which people may travel hundreds of miles to achieve. Marshland is filled in for cottage sites, dredged for marinas and used for sewage discharge and rubbish disposal from adjacent properties. The end result of the tourist's desire "to get away from it all" is often abuse of the shore, not only in bringing urban blight to the coastland, but also in the simultaneous destruction of biological productivity.

Of all the internal problems facing the marshlands, none is more serious than its vulnerability. While the process of succession is a natural geomorphological process, it can be affected by alteration of the land sea balance. Shifts of current and construction can provide tidal flats for invasion by marsh grass.

> Effective management and development of our coastal waters, lands, and resources require that man understand and predict the consequences of his actions. Although our understanding has increased markedly in the last twenty years it is far from complete. Although the problems are the same from one part of the country to another, each estuary is different and requires study peculiar to its individual characteristics. (5.)

There is an all too prevalent attitude among coastal zone residents to perceive marshland as wasteland without beneficial value. (6.) When measures to preserve them as a part of the coastline become imperative (e.g. erosion) false economy is often given first priority.

> Thorough study of a coastline by marine engineers and oceanographers should show how effects can be avoided, yet too often uninformed local authorities who do not want to hire the experts, construct jetties and breakwaters which do almost exactly what they are supposed to prevent. (7.)

New England estuarine marshland is being lost by extensive dredging and filling. In the East Coast area from Delaware to Maine, 45,000 acres of marshland were destroyed in the decade beginning 1954. Analysis of the situation over the past five years revealed generally unplanned and illogical use of these areas.

> Thirty four percent was lost to dredge spoil deposit, twenty seven percent to fill for housing developments, fifteen percent to recreational developments (parks, beaches, marinas) ten percent to bridges, roads, parking lots and airports; seven percent to industrial sites; six percent to garbage and trash dumps, and one percent to other causes. (8.)

The New England coastal loss average per state is 5.88% or 22,700

of 385,000 acres of total estuarine area. (9.) This misdirection and lack of planning in the use of coastal resources can lead to marsh destruction for indirect and sometimes dubious reasons. Lack of effective specific insecticides has led to the drainage of marshland by grid channeling as well as the introduction of chlorinated hydrocarbons into the food webs of the wetlands. Hydrological changes in estuary or marshland flow can be disasterous. Although insect control may be accomplished by drainage, the lack of water cover may eliminate some populations and introduce others. Considerably more damage, however, is done when the tidal activity of the marsh is closed off by dikes to control water levels. In the estuarine marsh system, the wetlands soon become exclusively fresh water environments with heavy mortality of delicate marine forms dependent on salinity. Yet another source of destruction is the complete filling in of marshes (used as refuse dumps) in the mistaken belief that terrestial rodent infestation originates in the marsh.

The main problem in each of these instances appears to be a basic inability to synthesize priorities for the marshlands by integration of existing data and conduct of special studies. The lack of this type of effort is well documented (10.), and due in part to little experience (at all levels of government) with the total and rational management of the salt marsh. The value of the salt marsh

as a biological asset has only been recognized in the last two decades (11.). The need to control all parameters affecting the marshland is being evaluated at present. (12.) Many wetlands preserved from commercial development have survived by accident rather than design. At all levels, from the private conservator to the Federal Government, acquisitions remain on a contingency basis. Sequential protection (the philosophy that the superior agency will ultimately acquire) while administratively expedient, does not always occur. Regulatory mechanisms vary greatly from region to region and in instances where specific legislation does not exist, adjudication and enforcement may fall in several jurisdictions. The overall result is a profoundly empiric attitude toward marshlands. While some forms of control have logistical assets, other mechanisms are distinct liabilities; none is ideal. To understand the need for reform in marshland practices, it is first necessary to explore present forms of use and control in these areas.

As with most coastal management problems the preservation and conservation of salt marsh resources precipitates debate on highly complex and inter-disciplinary issues. While development of marshland for industrial or residential purposes may be restricted or prohibited by state law, there is nothing prohibiting municipal apathy toward these properties or adjacent areas. Un-

why?

supervised marshland not only invites pollution but is actually self-destructive.

Fortunately, there is a growing trend toward recognition of the saltmarsh as worthy of protection by government and private groups alike. There exists, however, many issues of maintenance, preservation and regulation for these areas. In many instances funding for the upkeep of these areas is totally inadequate. Justification for improvements on virginal marsh held in that state for decades is often difficult to substantiate. In no form of management-control in current use can there be found a truly comprehensive plan for administration of tidal lands.

Individual ownership is the weakest form of protection. What may be an honest belief in conservation during prosperous periods may have to be sacrificed to other priorities in austere times. Few owners of marshland take sufficient steps to assure a continuation of their policies after death. Continued taxation of dormant land may create economic burdens. Enforcement of conservation and criminal regulations is usually absent or randomized. The private conservator usually lacks technical knowledge and funds to correct physical problems in the marshland, or to provide community use through community access. The goal expressed is little more than to save the lands in question from developers.

Private administration of marshlands ranks legally as the most expedient and efficient type of operation. Private corporations, usually non-profit organizations such as the Audubon Society, have a double enforcement mechanism for the control of access. Undesirables can be asked to leave the premises under threat of a trespass charge. If destruction of natural resources or property occurs, the administration can not only bring criminal charges, but also recover damages through a civil action. Most important of all, as private lands, these areas are subject to all laws.

The same problem limiting the private conservator affects the non-profit corporation--a lack of funding. When this is combined with a secondary interest in the marsh (i. e., it happens to be the place where birds nest, etc.) the legal advantages are soon wiped out. Limited funding affects personnel selection as well as provision of physical facilities. Having tied up most if not all working capital in the purchase of marshland areas, many naturalist-conservationist groups are forced to simply open virgin lands to limited access by a public hopefully empathetic and prepared to "rough it." These organizations are often forced to abandon educational and engineering functions of administration, leaving the marshlands not only unprotected but unexplained.

The Federal Administration of salt marshes assumes two forms loosely classified as commercial or custodial. The various departments and agencies of the government frequently acquire or have in possession coastal lands containing marshes. These federally owned lands are almost always outside the compass of state and local regulatory ordinances. Use of the property by the local agency is rarely if ever subject to review by peer and superior authority groups and consequently, marsh utilization is often unplanned and borders on the chaotic. This has included use for refuse disposal and sewage discharge.

Custodial care attempts to provide resource conservation, management, and general enhancement of the area. While these properties are outside local regulatory powers, good housekeeping practices are almost always incorporated into area regulations, both for the natural resources and tourist adducts. User failure to comply results in detention and hearing before a Federal Commissioner. Enforcement of these regulations is extremely difficult due largely to low employee/tourist ratios. For example, a campaign was launched by the Department of Interior at the Cape Cod National Seashore to encourage user reports of ordinance violations, as the Park service admitted openly that it lacked sufficient staff to patrol all areas. (13.) Maintenance facilities are usually

above average in the federally supervised areas, and other agencies are available to make physical alterations in the coastline to protect the resources.

Local and/or state supervision of marshland appears to be a promising form of co-operative administration. Financial resources are usually adequate in these cases. Tax appropriations frequently support upkeep and development, while in others admission fees from passes or stickers provide income. Local governmental units will often enact ordinances to promote upkeep and ensure conservation of resources. The users of these areas are more often than not regional residents, and usually exhibit concern and interest in area upkeep. Largely due to a lack of interstate publicity and frequent geographical isolation, the state and locally supported are not subject to the heavy traffic of federal areas.

An optimistic example of this type of joint supervision is the Bourne Bridge Park on the Cape Cod Canal, jointly sponsored by the Town of Bourne and the Commonwealth of Massachusetts Department of Natural Resources. While the majority of the land is given to picnic tables and camper space, some 20% of the area is estuarine marsh fed in part by the flood tide of the Cape Cod Canal. A minimum of landfill permits access from the picnic and recreation areas to the marsh. A banked path along the tributary edge

accomodates naturalists and shallow draft boating is permitted. Pollution is kept at a minimum as the park is provided with frequently placed and conspicuous refuse containers and sewage cisterns. The town provides custodial and public services including a bathhouse and supervised pool swimming. Despite near capacity use throughout the summer months, the park natural resources are relatively undisturbed and the major source of pollution continues to be the noise from the Bourne bridge which overpasses part of the land.

Unfortunately, not all marshland owners are interested in community service or conservation. Avarice and exploitation continue to be popular human vices and combined with ignorance as to the functions of marshland, pose a severe threat to these areas. Several states have recently enacted legislation regulating the use and abuse of marshland. In some instances, the acts are rational and scientific in approach to protection; in other instances, the legislation is an emotional attempt to endorse the ecology movement while simultaneously thwarting vested commercial interests. In order to better analyze the chinks in the legislative armor, there is a need to understand the salt marsh physically, biologically and socio-economically.

Marshlands vary greatly as to origin, contents and flow characteristics. Depending on source of water supply, strata and elevation, the coastal marshlands might be classified into three groups.

1

Exclusively marine marshes are largely the result of sea water seeking out depressions and paths of little resistance through beach or dune areas. Sand transport by wind and wave, possibly influenced by man made structures, may produce periodic flooding of low lying areas. With each repeated flooding, resistance to water entry is reduced and after some time cyclicity of regular flooding is established. If the proper species of marsh grasses become established in this area, a salt marsh is established. Erosive action on barrier beaches and dunes, however eventually destroys this type of marsh. The coastal marshes of Nauset, Cape Cod, are in part an example of this process.

2 Aquatic marshes may also occur along the coast. This is particularly so where substrata have pushed the watertable close to the surface, causing swamp and marsh areas to be generated above the high water mark. Storm tides and spring flooding establish connection with the sea, but saline water entry is limited throughout most of the year.

3 The true estuarine marsh involves both fresh and saline waters. Streams may join rivers in the marsh, where tidal action causes mixing of the waters, establishing an area of ecological transition between marine and aquatic lifeforms. Tidal action is regular and the degree of flooding is determined by the slope of the land.

Numerous attempts have been made to ~~zonate~~ zone tidal marshes. Amos (14) establishes as delineation, water depth at low tide and the extent of in-flooding at high water. He proposes the following regions: the salt marsh proper, which is flooded at high tide only; the tidal creek, which is deeply flooded at low water; and the tidal flat, only slightly flooded at low water. This system does not provide a transitional zone between the dry land and the marsh areas or account for the interaction between animal populations from both land and marsh. An alternative system for the New England tidal marshes was proposed by Miller and Egler (15.). They would devide the coastal area into three main regions. The upland is composed of forests and low shrub border at the highest area of flooding. This is the residential area for coastal wetlands inhabitants. The tidal marsh has four distinctive zones. The upper border most of which is damp but not wet, is composed largely of long grasses. Fowl and rodents nest in this area. The substrata is sufficiently solid to support larger grazing herbivores. The upper and lower slopes of the marsh display a gradation of plant and animal life with increasing salinity. This area is always wet and subject to tidal flooding. At the base of the slope there is also a lower border of grasses which usually serve as a breakwater, reducing wave action. The marsh then gives way to the bay or estuary.

The organisms in contact with these marshlands compose four groups, each a specific part of the process of energy transfer in the ecosystem. The producers may be thought of as those organisms capable of energy producing synthesis by sunlight and the use of inorganic material. Green plants, algae and bacteria provide the marsh with carbohydrates, oxygen and proteinaceous precursors. Consumers have no ability to photosynthesize and therefore must obtain food by eating primary producers (herbivores), other consumers (carnivores), or both (omnivores.) The decomposers, bacterial and fungal species, re-cycle organic and inorganic materials to simple compounds which re-enter the ecosystems. Tidal action carries much of this material out and along the coast, where it sinks and helps to form the nutrient rich detritus. Interaction between members of these groups may be compared to a series of pyramids, each apex resting on the base of the preceeding figure. The efficiency of each level in energy transfer to the next is minimal.

> A thousand pounds of diatoms, which is an unimaginable number of diatoms, make about a hundred pounds of animal plankton, which in turn make only ten pounds of fish. At every level in the pyramid about 9/10ths of the energy is lost as energy or heat. (16.)

Small alterations in the physical chemical mellieu of the marshes therefore can be biologically disastrous. This in turn upsets population regulation and mechanisms. The marshlands are

spatially limited horizontally and vertically as to productive areas. There is simply not enough room to produce the food surpluses necessary to overcome pollution. The larger animals of the tidelands, birds, rodents, and mammals all have means to travel over wide areas to obtain adequate food, or else omnivorous appetites are well adjusted to variation in biological production. The larger the animal, the more difficult, of course, is the task to find sufficient food in the local area. Resultingly, there tends to be few species of larger animals, and these tend to be widely distributed over the wetlands or transiently foray into the coastland. A type of reciprocity exists between coastal and marsh populations and nutrients, a dualistic reservoir of nutrients in time of ecological stress.

The basis of the saltmarsh life pyramid is its vegetation. Accordingly, many of the pollution problems encountered in marsh destruction involve interference with plant metabolism. Three species of grasses are commonly encountered in wetland ecosystems. Zostera marina is limited to bars and sand spits near or just offshore. Less than two feet high, with flattened blades, it is the first thrust of terrestial vegetation into the sea and the first biological mediator of wave action. Spartina alterniflora with blades growing to one half inch at the base and to a maximum of ten feet long, is the primal wave barrier along tidal creeks. Spartina patens, finer

and not exceeding two feet in height, constitutes much of the salt marsh "carpet." It is the dead crop of S. patens collected in the same area year after year by the confines of taller grasses and wave action that provides much of the marshland peat. Many smaller delicate organisms utilize this mat of decomposing grass for physical protection. Decomposing organisms simultaneously break down grass structure entrapped nutrients and compounds. Pollutants interfering with any portion of this mechanism can upset a multitude of ecosystems.

Several social scientists (17, 18.) have suggested that location in coastal development is of major importance and that marshland may be safely transplanted or developed in coastal areas. Such reasoning is both hydrologically wrong and at present technologically impossible. Information is lacking on the propagation of marshland flora, the basis for all life in the wetlands.

> Unlike most grasses used for forage, turf, or to stabilize roadsides and other inland areas, little is known of the growth needs of the salt marsh grasses invading the barren tidal flats. We do not yet know for instance, the maximum duration of flooding these grasses will tolerate or their response to salinity or fertility. (19.)

To date synthetic or semi-synthetic materials do not support the flora sufficiently well for marsh establishment. Therefore the preservation of existing marshgrass populations is essential and the avoidance or reduction of pollution in these systems must be encouraged.

Effects of sewage discharge in the coastal area and especially in areas of restricted flow such as marshlands include: odors, altered populations, plant overgrowth excluding or limiting light, toxic algae, and ultimately sterility of the entire region. (20.) The problem of blue green algal overgrowth feeding on sewage nutrients is particularly serious.

> When a toxic strain becomes predominant in a water bloom, hundreds of birds die in a few hours. Then any living creature that drinks the water is a potential victim and the shore may be strewn with bodies of mammals and waterfoul. (21.)

In areas of limited flush as the marshland, it is desirable to keep surface waters as free of algal growth as possible.

Sewage discharge through, into, or around tidal marshland is one of the most insidious forms of coastal pollution. Effluent may pass through these regions and produce multiple adverse effects on the wetland ecology. Lack of building codes or their enforcement often allows the discharge of sewage directly from residences; some treatment facilities in rural areas may actually employ marshlands as initial discharge points. The shoreline area of New England faces a particular danger.

> Although problems with sewage disposal occur throughout the nation, some of the most severe occur in small coastal resort areas that must accommodate a massive influx of tourists during the warm summer season, along with skyrocketing use of boats with toilet facilities. (22.)

The problem is further compounded by the incorrect siting of proper disposal methods i. e., septic tank leech fields, cisterns, cesspools, which may still pass dissolved nutrient matter into marshes. Raw sewage may additionally contain pathogenic microorganisms which could affect human and animal populations. Offal from a poultry house in Maine, for example was dumped into an estuary, whereupon the local waterfoul population was decimated by cholera.

Ecological imbalance in the marshland may also occur through mechanisms not normally considered to be waste discharge. Proximal urban development or industry provides harmful adducts to wetland metabolism. Changes in salinity by salted runoff from roads treated in winter and fall can eliminate or severely reduce holding plant populations from the previous growth season. Emergent plants are usually more tolerant of salinity changes than submerged species. In either case however, the damage pattern is identical; plasmolysis of cells in leaves and stems creates internal osmotic changes producing cellular death. Salt runoff can therefore act as a random species selector for marsh plants. Variation of salt content by caprice or plan can cause elimination of a particular species from a given area. Salinity of 6 percent and above is detrimental to many submergent waterfowl food plants. (23.)

Other toxic economic agents can have detrimental effects on the marsh. Pesticide residues are a natural consequence of agri-

cultural irrigation and runoff. These compounds affect game birds, and one study has recovered 7 mg of DDT and related metabolites per kilogram of duck tissue. (24.) Tributary streams may contain hazardous amounts of native or industrial minerals in toxic concentrations. These may occur by percolation through slag heaps, exposed cuts or more often, placer deposits. Their concentration and accumulation by estuarine species as well as transient mammals is well documented. Toxicity may result from any of five mechanisms.

> Substances behaving as antimetabolites; substances forming stable precipitates or chelates with essential metabolites; substances catalyzing the decomposition of essential metabolites; sustances combining with the cell membrane and effecting its permeability; substances replacing structurally or chemically important elements in the cell and failing to function. (25.)

Examples of such toxic products include sulfides and sulfur acids from mining operations; arsenic and antimony from natural deposits; and cadmium or lead salts from smelters. Of primary concern in this type of toxicity is the ability of commercially harvested shellfish to concentrate toxic metallic ions which are then ingested by the unwary consumer. (26.)

Nor is the list of pollutants limited to biologically active agents. While the zones of the marsh are transitional stages from the open sea to the dry upland, acceleration of the process by landfill operations not only destroys sheltered ecosystems but also creates changes

in waterflow from the sea and land. Dredging invariably accompanies landfill as a source of needed soil and to provide access to the sea for local residents. The result is a cycle of endless interference.

> Another form of misuse...occurs in those areas where exposed barren sand flats have been created by marsh destruction or dredging. These unprotected areas are subject to serious erosion which in time will fill channels necessitating further dredging and this contributes little to the needs of wildlife or man. (27.)

The turbidity resulting from such operations is detremental esthetically and biologically. Photic levels for planktonic and algal communities are altered; many invertebrates cannot effectively rid their gills of silt in sufficient quantity to continue life under such circumstances.

Deepening or dredging estuaries may also upset predator-prey relationships in the marshes. Deep water forms may actively predate juvenile forms and organisms dependent on the spatial limitations of the wetland for defense. Accordingly, consumers resident in the marsh may be deprived of sufficient food stocks and either be dislocated, reduced in population, or eliminated entirely.

Changes in hydrological profile by adjacent populations may also affect marsh populations. Diversion of water may not only accelerate wetland transformation, but alter salinity profiles. Road construction, bridge erection, and the mere close presence of man

and his construction technology may alter saline balance in the marsh. Coastal wells may become tainted with salt or sewage; fresh water may be retained behind commercial or agricultural improvements, the result being upset of ecological balance and even lowering of property and esthetical values. Consideration or control of this type of problem is often disregarded in coastal zone management.

The health of the marshlands, therefore, is of crucial importance to marine and terrestial coastal communities alike. Biologically a hundred fold more productive than agricultural land or the open sea, the marsh is both nursery and food supply to many marine, aquatic, terrestial and airborne species. Geologically it reduces chance of inland flooding and water pollution through the uplifting process of succession. As the zone of transition between sea and land it benefits from, and is subjected to both spheres of influence. The marsh is subject to constant change, and efforts to restrict or abolish this ability are potentially disastrous.

> The ribbon of green marshes, part solid land-part mobile water has a definite but elusive border now hidden, now exposed as the tides of the Atlantic fluctuate. The marsh reaches as far inland as the tides can creep, and as far into the sea as marsh plants can find a roothold and live in saline water. (28.)

This geographical fact is often overlooked in the utilization of marshlands. There is a research gap in all aspects of the marsh

and adjacent areas as well, retarding effective assessment of ecological damage. When this fact is coupled with the popular tendency to view the marsh as exclusively terrestial, or to a lesser extent (in some regulations) exclusively marine, use and user conflicts develop. The resolution of these problems, whether by mutual agreement or imposition of authority should be evaluated not only on the basis of scientific rationales but also in the light of community opinion on the problem and regimes for its solution.

The definition and analysis of attitudes affecting salt marshes and other wetlands is largely dependent on the marine orientation of those parties with interests in the area. This concept might be thought of as a reliance, trust, or commitment to the sea.

> Dependence was viewed largely as economic in nature although in its broadest sense, the term must also include psychological dependence as well. People who live by the sea may find that it fulfills an inherent need within them over and above any economic benefits derived from it. (29.)

In states with extensive inland areas, attempts to regulate coastal use and development may be frustrated by a large proportion or outright majority of the active electorate with little or no understanding of the coastal region. If migration between coastal and inland areas is active, a large segment of the coastland population may be either apathetic or hostile to rational use and protection of local resources.

The major area of impact on the wetlands is economics. A commonly advocated position towards coastal resources is to maximize uses until conflicts occur, and then adjudicate them on the basis of cost benefit analysis. While financially expedient at first, this policy gives little attention to impact on other less easily measured aspects of the economy. In an eagerness to enlarge the tax base, coastal communities frequently overlook the cost of public services to industry and social costs due in part to pollution, breakdown of coastal geology, and change in recreational patterns. When industrial development commissions and conservation agencies clash over the use of the marsh the result is frequently chaos.

> Pressure even comes from state officials who are trying to encourage industries to come to their area by offering filled marsh for building. The battle between the forces of development and conservation need only be won once by the developers, but must be fought and won every year for conservation to triumph. (30.)

Filled in marsh may provide increased revenue and employment for a community but research has yet to quantify the effect of wetland destruction on the fishing industry stocks, both shell and fin. The economic effect is difficult to analyze, as fishermen will seek alternate grounds for some time before surrendering their occupation. It is theoretically possible for added revenue obtained by salt marsh sacrifice to industry to be wiped out by ecological effects harming other resource based industries in the area.

Mention must also be made of investment from outside the coastal zone. Geographically removed from the area of land-sea interaction, these investors are often oblivious or disinterested as to the effects of their financing. This can produce social backlash on the part of local residents. Alteration of long held aesthetic or recreational patterns may occur, or elements of the economy may be affected by such alterations. The local attitude is frequently one of helplessness, as absentee ownership precludes direct recourse in many instances.

> Many of the coastland's inhabitants...are anxious for the Federal government to expand on its various commitments in the Bay area, but are wary, lest these commitments, or those of other agencies, seriously interfere with the physical nature of the bay as it now exists. They resent interference with the activities of the present interest groups in the Bay area, yet appreciate the need for expanded development of the marine resource potential. (31.)

Social priority may also affect the fate of the marshlands. Environmental education, a product of ecological renaissance in the last half of this century, is fighting a defensive action against abuse of non-renewable resources by civilization and its technology. A large measure of this effort is directed towards altering self or interest centered concepts to group and society centered goals.

This is being accomplished on three fronts. Strictly private organizations, such as the National Wildlife Federation, publicize

the ecological importance of wetlands through journals, mail campaigns and advisory service. Local chapters and affiliates of these national organizations often aid passage of protective legislation as well as arouse community interest in marshlands as centers of biological productivity. Complimentary groups, involved in the protection of the coastal zone generally, may exert a synergistic effect on wetlands use and development.

Academia must not be overlooked as a method for modification of attitudes toward the salt marsh. A major and quite recent change in educational philosophy is that simply listening to material is not an efficient means of learning. Associations are formed by active participation in field and laboratory study which are far better remembered than material presented didactically. When the natural sciences and particularly limnology and marine biological courses are presented at least in part through case study and field work, there is often a lasting impression formed concerning the role of the salt marsh in the ecological transition from land to sea.

Priorities are also being altered through the work of certain agencies of the Federal government. In many instances, unwise use of marshland has been based largely on economic expedience in handling social problems, such as refuse and sewage disposal. The Clean Water Restoration Act of 1966 is designed to relieve such situations by providing a mechanism for federal financial and technical

aid in the construction of waste treatment plants and ancillary facilities. Another powerful tool, though often unused, is the ability of the federal government to withhold specific funding if acceptable standards are not submitted for environmental and ecological pollutants. This type of action need not be limited to coastal zone project funds, but could conceivably affect other public works, health, education, or welfare programs.

Attitudes of coastal zone residents toward wetlands are difficult to quantify. In a region where many residents are only seasonally present and political-economic problems of tourism and resource based industries make individuals reluctant to divulge opinions, survey techniques ~~are~~ analytical methods are of crucial importance in assessment of use and development of the marshes. A recent study of attitudes in the Southern Rhode Island coastal zone, while flawed technically in data collection, does however give some trends and areas of correlation in social influences on salt marsh use and development. These would appear to include educational and income level, as well as length and type of residence in the area. (32.) Of particular note is the fact that most marsh owners were unaware of the existence of protective legislation, but felt the best use of their property to be preservation, largely for conservation purposes. (33.) This appears to indicate that private ecological

groups are having greater impact than the occasional and often secondary efforts of the state governments in the area of environmental awareness and its legal-political implications. Additional studies are needed to discover if this attitude has correlation in other states with similar statutes and whether it extends to peripheral but related legislation (e.g. waste discharge, etc.) A noticeable lack in current wetlands and coastal zone legislation is a specific mandate for education concerning coastal resources.

Public acceptance of wetlands control and development by a state authority may be a real obstacle to success in these programs. It may be assessed by attitude study, but in any case prophylactic inclusion of resident laymen from the coastal zone area is preferential to local hostility culminating in civil injunction. Such matters as invasion of privacy, wants and desires of theprivate sector, and community priorities must receive recognition through either free and unrestricted testimony, or committee membership. The rational and constructive use of eminent domain and selective rights appropriation (water, air, scenic, or mineral) combined with appropriate tax exemptions, is preferable to wholesale condemnation and seizure of marshlands. The latter course is most likely to antagonize coastal zone residents, who may even seek relief at the polls.

Attempts to integrate scientific and social data concerning marshes into relevant and adequate legislation have been only partially successful at best. Most of the inadequacies are due to a failure to recognize, provide for, or enforce one or more of the major goals of coastal protection and management. The following, while originally suggested as objectives for a national coastal zone management policy, are nonetheless inclusive of goals in a state legislative program for wetlands.

> Encourage urban and industrial growth and the resulting land use in a manner to preserve the maximum of the estuarine and coastal zone resources and to insure the greatest number of beneficial uses.
> Recognize that estuarine-dependent land uses require preference and that some uses such as residential and some industrial uses do not need shoreline locations.
> Conserve the estuarine and coastal environment to sustain and enhance it's nursery value, it's wildlife habitat, and it's commercial fisheries value.
> Develop and make accessible the many forms of outdoor recreation and the aesthetic values offered by the estuaries and coastal areas.
> Reduce to an acceptable minimum the adverse effect of man's use of the estuaries and coastal areas and accept preservation as one means of reasonably guarantying the opportunity to exercise future options. (33.)

The implementation of these objectives, however, has often been hindered by structural problems in state administration. Several states, particularly in the Southern region, have attempted to control wetlands use by a concerted application of regulations protecting individual resources or resource groups. While fish and game or

or water pollution regulation does, at least in part have relevance to marsh management, these laws do not protect the lower portions of food webs found almost exclusively in the marsh. The state of Connecticut has had a similar problem in that control of dredging and filling has been from the sea to landward, as partially submerged land has been under the aegis of the rivers and harbors commission. It is obvious that attempts to include marshland protection in the existing programs of various related agencies has been expedient, but not realistic in approach.

A logical alternative is the establishment of a single agency, either a given department, or a new entity within the framework of the state government for the management of wetlands and coastal resources. The comprehensive program of the Massachusetts Department of Natural Resources or the marine related work of the Maine Environmental Improvement Commission are examples of this type of organization. When the evaluation of data on marshland priority is beyond the expertise of the natural scientists in such agencies, the necessary consultants may be hired, or in the case of Rhode Island, elevated (in part) to commission status. In each of these instances, there is a need for several clearly defined areas of power: to evaluate and ~~zonate~~ zone coastal lands; to enforce these rulings by civil or criminal process including eminent domain and condemnation; to have access to legislative and other branches of

of government to aid in resource management and protection; and ultimately, the ability and mechanisms to consult and evaluate the attitude of the coastland citizenry towards the agencies' goals and objectives.

The scope of this type of legislation is also of great importance. Several acts appear largely concerned with the physical definition of the tidelands area, while others deal almost exclusively with the mechanisms of regional planning and development. An example of the former is the Michigan Shorelands Protection Act of 1970. (34.) It provides for accurate definition of wetlands areas, giving order of concern for these lands, and creates a 1,000 foot buffer zone around tidal areas from the point of the highest water mark. This ecological no-man's land helps to avoid abuse of the estuary and marshes by prohibiting close siting of unauthorized structures and improvements. The legislation fails to establish mechanisms investigation needs and problems and ultimately leaves the designation of areas worthy of conservation to the legislature. This act is logistically a poor piece of legislation. It provides at best only selective protection of marshlands, and this is subject to bureaucratic and political chance. A permit system protecting all marshlands is a more realistic method to regulate resources and processes which at present are only rudimentarily quantified. Two

types of arrangements are possible for the administration of this permit system. Licenses can be issued by parallel agencies with specific enforcement duties, as in Rhode Island, or by a comprehensive development commission with authority over all phases of the environment as in Maine.

In the State of Rhode Island, legislation affecting the use of marshland is scattered among several bills. While each attempts to serve a specific purpose in the development and protection of natural resources, none can be termed comprehensive with regards to the marshland.

The Green Acres Land Acquisition act of 1964 attempts to eliminate some of the administrative problems connected with ownership of recreational property.(35.) Concerning conservation and development of land for this purpose the act states:

> The General Assembly hereby finds and declares that: Providing land for public recreation and the conservation of natural resources promotes the public health, prosperity, and general welfare, and is a proper responsibility of government. (36.)

The Act includes by definition wetlands and marshlands preservation, and includes in the specific definition of land, water and riparian rights and easements.

Recognizing some of the problems mentioned earlier in the administration of marshland and other recreational areas by local

governments and/or private groups, the Green Acres act in Rhode Island encourages the following: endorsement of contiguous local units of government to create co-operative plans for the use and control of shared properties; to financially aid (through grants) local governments with lands worthy of protection; the issue of rules and regulations for the public use of its holdings and the acquisition of lands through private sale. The director is given the authority to survey park requirement needs, future acquisition, unique sites and multiple use areas. He may "...enter on any lands for the purpose of making surveys, borings, soundings, or other inspections and examinations." (37.)

During the 1965 session of the Legislature, an act was passed giving legal status to local Conservation Commissions. According to the legislation some of the objectives of these organizations should be:

> ...to promote and develop the natural resources to preserve natural aesthetic areas within said municipalities; to keep an index of all open spaces with (sic) the city or town, including open marshland, swamps, and other wetlands for the purpose of obtaining information on the use of such areas. (38.)

Largely, if not exclusively dependent on local funding, these commissions (currently numbering 17) operate with difficulty and the lack of a clearly delineated position in the administration of natural resources.

In the area of reception-acquisition of lands and arrangements for development, many agencies serve as the local basis for the Green Acres Act but appear powerless to check acute environmental abuse in the coastal zone. A statewide co-ordinating committee composed of individual commission members has been established to serve as a liason between state and local authorities.

In the same year, the Marshland Zoning act was passed. This legislation restricts the use of wetlands to public betterment, i. e., public health, marine fisheries, and wildlife conservation purposes. The Department of Natural Resources is given considerable authority and latitude to fix and define these terms. (39.)

The General Assembly in 1967 adopted the Intertidal Salt Marsh law, similar in content to acts passed by other coastal states. This prohibits the dredging, filling or otherwise disturbing the saltmarsh ecology by mechanical means without a permit from the Department of Natural Resources. The Department does not have condemnation powers, nor is there available sufficient funding for a major program of acquisition.

> Current policy more or less prohibits any filling. Several applications to fill have been turned down, at least two dumps shut down, and a number of activities stopped. (40.)

Enforcement is administered internally by the department through the Divisions of Conservation and Enforcement. As of May 1970, there has not been a court test of the law.

The Coastal Resources Management Council Act of 1971 concerns itself in part with the role and protection of salt marshes. The authority of the ~~CMRC~~ CRMC is limited above the high water mark to those powers necessary to carry out effective resources management programs in several broad coastal areas including, "intertidal salt marshes," and "Shoreline protection facilities and physiogeographical features," (41.) and possesses authority to "...issue, modify, or deny permits for dredging filling or any other physical alteration of salt marshes." (42.) The enforcement power is delegated to the Superior Court.

There are several problems in the Rhode Island legislative package. In a state where towns and cities compare favorably with county organizations in other regions, the local Conservation Commissions Bill was obviously designed to give localities some degree of participation in the state-wide management of wetlands areas. By not accurately defining goals and objectives however, it may be possible for the State government to bypass these agencies. The administration of marsh control and protection, while concentrated in one department, is spread over a bewildering array of divisions

in the Department of Natural Resources, providing ample opportunity for the bureaucratic process to accidentally (or intentionally) snafu adjudication of problems. This is further complicated as the relationship between the Division of Enforcement and the judicial authority, (the Superior Court) is neither specificed or delineated. It is obvious that legislation affecting the wetlands in Rhode Island might be regarded as a series of stop-gap measures lacking unity and coherence, while simultaneously subordinating regional planning needs to local interests.

The alternative is a comprehensive state level agency charged with the protection of all phases of the environment. Legislation such as that of Rhode Island, does not take into account abuse of adjacent property to wetlands which may cause damage to them, or to direct sources of marshland damage by processes other than mechanical/physical. The Maine act "To regulate site location or Development substantially Affecting the Environment" (43.) is an example of legislative effort to produce a bill which intrinsically covers internal as well as external adjacent ecology of the wetlands. The act authorizes the Environmental Improvement Commission of the State to exercise the:

> ...police power of the state to control, abate and prevent the pollution of the air, water, and coastal flats; and prevent diminution of the highest and best uses of the natural environment of the state. The Commission shall make recommendation to each subsequent Legislature with respect to the classification of the waters and coastal flats and sections thereof within the state based on reasonable standards of quality and use. (44.)

It requires notification by any person constructing or operating a development of any area under the purview of the Act to give notice of intent to the Commission before start of operations. The Commission may approve the project or require a hearing. If the latter proves necessary, public notification of the hearing must be made, and interested parties are urged to testify. The following criteria must be met before approval of operations can be granted.

> 1. Financial capacity. The proposed development has the financial capacity and technical ability to meet state air and water pollution control standards, has made adequate provision for solid waste disposal, the control of offensive odors, and the securing and maintenance of sufficient and healthful water supplies.
>
> 2. Traffic movement. The proposed development has made adequate provision for loading parking and traffic movement from the development area onto public roads.
>
> 3. No adverse affect on the environment. The proposed development has made adequate provision for fitting itself harmoniously into the existing natural environment and will not adversely affect existing uses, scenic characteristics, natural resources, or property values in the municipality or in adjoining municipalities.

> 4. Soil Types. The proposed development will be built on soil types which are suitable to the nature of the undertaking. (45.)

Failure to inform the Commission of the intent to modify or develop, may result in a restraining order issued by the Attorney General. Failure to comply with the order results in civil action by the Commission.

For as efficient as this act is legally, it is resting on an unscientific footing. The role of the upstream riparian in marsh health is not acknowledged or controlled. Of crucial importance is a lack of definition of terms, particularly of "waters" and "coastal flats." Although boundary distinctions generally define political waters, the nomenclature of the intertidal zone is sufficiently nebulous at present as to invite juridical concepts of the same term which may be entirely different. The need for interdisciplinary cooperation in this area is obvious.

The best protection for marshland is use and development legislation which is sound legally and scientifically. Preservation and management of America's remaining marshes cannot be left to caprice or change, nor should the negative effect of unfavorable judicial opinion be underestimated. Commercial and vested political interests, confronted with the inevitability of conservation and use legislation as well as executive mandates will attempt to

secure relief from them by exhaustive legal attack. If they succeed, the time between nullification and new legislation can extend into years. In the interim, the plunder of the marshlands would continue. Unless there is agreement as to the need and scope of marshland conservation, the result will be an ecological Apocalypse.

REFERENCES

1. Welch, Paul T., Limnology, 2nd ed. New York: McGraw Hill Book Company, 1952. p. 19.

2. Teal, John, and Teal, Mildred, Life and Death of the Salt Marsh. Boston: Little, Brown and Company, 1969. p. 254.

3. Federal Water Pollution Control Administration, "Recreation," in Water Quality Criteria. Washington: United States Government Printing Office, 1968. p. 7.

4. Outdoor Recreation Resources Review Committee, Outdoor Recreation for America. Washington: Government Printing Office, 1962.

5. Commission on Marine Science, Engineering, and Resources, Science and Environment. Washington: Government Printing Office, 1969 vol. III p. 3.

6. Amos, William, The Life of the Seashore. New York: McGraw Hill Book Company, 1966, 1969. p. 191

7. Ibid., p. 193.

8. Commission on Marine Science, etc., op. cit., p. 37.

9. Ibid.

10. Commission on Marine Science, Engineering and Resources, "Management of the Coastal Zone," in Our Nation and the Sea. Washington: Government Printing Office, 1969. pp. 49-82.

11. Editorial, "Endangered Edge of the Sea," Life, 65 (3):4, 1968.

12. Hull, Richard J., 1972: "On Managing a Salt Marsh," Maritimes, 16:2, 4-7.

13. "Letters to the Editor," Provincetown Advocate, Sept. 3, 1971, p. 5.

14. Amos, op. cit., pp. 120-1

15. Miller, W.R., and Egler, P.E., 1950; "Vegetation of the Wequetequock-Pawcatuck Tidal Marsh, Connecticut," Ecological Monographs, 20, 141-172.

16. Amos, William, The Life of the Oceans. New York: Mc Graw Hill Book Company, 1966, 1969. p. 121.

17. & 18. Rorholm, Niels, Bulletin 374 Agricultural Experiment Station, URI. (Economic Impact of Narragansett Bay) Kingston, 1963.

19. Hill, op. cit. p. 8.

20. Olson, T.A., "Blue Greens," in Waterfowl Tomorrow. Washington: Government Printing Office 1964. p. 349-356.

21. Water Quality Criteria, p. 91.

22. Ibid. p. 47.

23. Tester, J. W., 1963. "The Influence of Sodium Chloride on the Growth and Reproduction of Sago Pondweed." unpub. MS Thesis, Utah State Univ.

24. Keith, J.A., 1966. "Reproduction in a population of Herring gulls contaminated with DDT." J. Applied Ecology, 3:57-70.

25. Water Quality Criteria, p. 85.

26. Blais, Gerard D., 1970: "Aspects of Marine Biology for Pharmacy Practice in Rhode Island," URI Pharmacists' Quarterly, 4, 2-4.

27. Hill, loc. cit.

28. Teal and Teal, op. cit., p. 3.

29. Alexander, Lewis M., Narragansett Bay: A Marine Use Profile. Washington: Geography Branch, Office of Naval Research, 1966. p. 108.

30. Teal and Teal, op. cit., p. 266.

31. Alexander, op. cit., p. 109.

32. Fischer, David, W., Southern Rhode Island Coastal Zone Attitudes. Kingston: Sea Grant Occasional Paper #71-002., 1971.

33. Ibid., p. 7.

33a. Ludwigson, John O., "Policy and Objectives of a Comprehensive National Estuarine and Coastal Management Program," In Environment Reporter, Monograph #3, "Managing the Environment in the Coastal Zone," May 1970. Washington: Bureau of National Affairs p. 13.

34. State of Michigan, "Shorelands Protection Act," in Environment Reporter Solid Waste and Land Use. Washington: Bureau of National Affairs, Inc. 1972 p. 1211:2121-2122.

35. Annotated Laws of Rhode Island, ss. 32-4-1 to 32-4-15, New York: Bobe Merril Company, 1968. (Hereafter referred to as ALRI)

36. Ibid., ss 32-4-2.

37. Ibid., ss. 32-4-14b.

38. Ibid., ss. 45-35-1

39. Committee on Marine Science, etc. op. cit., vol. 3, pg 37.

40. Ludwigson, John O., "Rhode Island Regulation," In Environment Reporter, Monograph #3, op. cit., p. 9.

41. ALRI, ss. 46-23-6.

42. Ibid., ss. 46-23-6A.

43. State of Maine, "An Act to Regulate Site Location of (sic) Development Substantially Affecting Environment." in Laws and Procedures of Power Plant Siting in New England. Boston: N. E. River Basins Commissions, 1970 p. E-1 to E-5.

44. Ibid., p. E-1.

45. Ibid., p. E-3-4.

Abstract

The following model wetlands protection act has been designed to operate in states without a Coastal Zone Management Authority. It utilizes the facilities and advice of the Department of Natural Resources, yet is the sole issuing authority for wetlands alteration permits.

Several clear problems in this type of legislation have been overcome. One is the inclusion of purely aquatic systems and swamps (generically) within the act. Another new feature is the making of unauthorized alteration of the wetlands a criminal act, and providing heavy penalties for its violation, with a provision that if so required, the damaged areas must be restored to the natural state.

Commission membership is equally divided between citizens, scientists and administrators. The act authorizes that the Director of the Department and a legal counsel sit ex officio and without vote.

Provision is also made for public environmental education and financial assistance for towns desirous of preserving wetlands. A minimum budget for acquisition of lands is set, and the power of eminent domain is vested in the Commission, along with authority to purchase selected rights to wetlands in private hands.

The act is basically a synthesis of Maine and Rhode Island legislation, with significant alterations in scope, definition, and purpose.

****

Preamble

The Legislature of the State of _____, herewith recognizes;
a.) that the wetlands of this state constitute a non-renewable resource, and as such are to be afforded the protection and conservation set forth by the State and its agencies for such resources;
b.) that alteration of the wetlands and their ecology, can elicit harmful economic, sociological, and biological effects on the people of this state;
c.) that wetlands may be harmed by encroachment and pollution, either terestially or from riparians;
d.) and that wetlands offer the people of this state unique opportunities for recreation and education,
hereby enacts the following:

1. The following shall be known as the Model Wetlands Development and Protection act.

2. Within the context of this chapter, the words and terms hereinafter listed shall have the definitions following:

a.) Department - the Department of Natural Resources of this state.

b.) Commission - The Wetlands Protection and Development Commission of the Department of Natural Resources.

c.) Wetlands - all lands and physiogeographical features intermittently covered by the waters of this state. The area shall include, in the case of tidal waters, all lands up to and including the greatest high water mark; or in the case of aquatic non-tidal systems, the area included to the maximum limits of spring flooding, and inclusive of all areas in which there is emergent vegetation rooted in submerged soils; and the term shall include, but not be limited to marshes, tidal flats, swamps, and intermittent beds of streams and rivers.

d.) Boundary zone - that area enclosed by a perimeter of not less than 1,000 (one thousand) feet from the high water mark of a wetland area or limit of maximal spring flooding.

e.) Adjacent waters - all waters tributary to, or directly adjacent to wetlands.

f.) Impact Study - the evaluation by the commission, agencies or special study groups appointed by the commission for such purpose, of the effects of proposed improvements, modification, or alteration of wetlands, adjacent waters or boundary zone.

g.) Permit - The license granted by the Commission to applicants planning to alter, modify, and/or develop wetland areas within any restrictions or purview enjoined by the commission.

h.) Ecological systems,ecosystems, ecology -- the total biological interrelationships between faunal and floral species of the biota permanent to or in contact with, any wetlands area, and the biophysical and biochemical relationship of that biota to the physio-geography of that area. The Commission shall from time to time conduct surveys, assays, and evaluations of wetlands and wetlands biota to determine what constitutes said systems, in co-operation with the Department of Natural Resources, for this state.

3. The Commission shall be organized as follows:

a.) The Director of the Department of Natural Resources, to sit ex officio.

b.) Three (3) division Chiefs of the Divisions of the Department of Natural Resources, appointed and in rotation by the Director each to serve a term of one year.

c.) Three scientists one with expertise in marine biology, one with expertise in coastal geology, and one to have expertise in sanitary and environmental engineering; each to have attained the doctor's degree and to be appointed by the Director from a list supplied by the Commissioner of Education; further provided that one scientist shall be appointed to a term of one year, one to a term of two years, and the third to a term of three years.

d.) Three residents of the state; none of whom shall qualify for appointment in sections b. or c.; they shall be appointed by the Governor from a list prepared by the Secretary of State. Said terms to be as prescribed for section c.

e.) A legal counsel, to sit ex officio

f.) The Commission shall meet not later than on the fifteenth day of the month of January annually, for the purpose of organization. The Commission, meeting in session, shall elect from its membership a Chairman and Secretary.

g.) The Commission shall annually submit to the director, a general budget for the following fiscal year. Said budget to be included in the appropriation for the work of the Department of Natural resources and subject to approval by the Legislature and governor.

4. It shall be unlawful for any person or persons, legal or real, to dredge, modify, fill, or alter any wetlands or adjacent waters, or the ecological systems therein without a permit issued by the Commission.

5. Any person who desires to dredge fill, modify, or alter wetlands shall give notice of such intent not less than thirty (30) days before start of operations, to the commission in writing. Said notice to act as application for hearing before said commission, and contain a full description.

6. The Commission shall meet not later than 14 days after receipt of such notice, and receive testimony and evidence in said matter. It shall remain with the applicant to show just cause why the application for permit should be granted. The commission may require an impact study of the proposed project to be prepared, said study be conducted by the commission, the department, or its authorized agents. A permit for the modification of the wetlands in application shall be granted if in the opinion of the two thirds majority of the board:

a.) that the proposed modification to the wetlands therein described does not unfavorably alter the geography, ecology, tidal flow, discharge, or general functions of the wetlands in application, its boundary zone, or adjacent waters;

b.) that the applicant possesses sufficient funds and equipment to complete the project as described in application for permit, and that such construction of the modification shall not generate unacceptable levels of noise, chemical, physical or mechanical pollution. Provided also, that the applicant shall at such times as the commission shall determine, shall furnish the Commission with such environmental studies and progress reports as the Commission shall desire;

c.) that the proposed modification shall be in the public interest and represent the highest and best possible use of the environment of that area and that the modification shall, whenever deemed necessary by the board, be altered to blend into the topography of the surrounding area;

d.) Nothing shall prevent the commission from authorizing such additional criteria and standards for the issuance of permits as deemed necessary by it for the protection of the wetlands.

7. Any applicant party or parties as defined in section 4, who does not file letter of intent, or otherwise make application to the Commission for a permit as described in section 5, and/or begins modification of any wetlands area or adjacent area without notification to the board shall receive warning by notice of registered mail that the party or parties is in violation of said sections. Whosoever refuses to cease and desist from such modification after notice of violation, shall cause to be issued by the Attorney General upon the advice of the legal counsel of the Commission a warrant for arrest. The jurisdiction for the trial shall be set in the Superior court of the state. The penalty for conviction shall be not less than one thousand dollars per day of violation, or not more than twice the value of the proposed modification, including all buildings and improvements to be erected on same. Further, at the direction of the Commission and the court, said defendant to remove all improvements and modification, and restore all areas involved to a natural state, the degree of which shall be determined by the appointees under section 3, a and b.

8. For the purposes of investigation and enforcement of this act, any member of the Commission, Divisions of the Department, or their employees or agents, acting under written order of the Commission, may enter upon wetlands and waterways for the purposes of inspection, evaluation, and collection of samples, data, and/or evidence as the Commission shall direct. Said entry to be made in which the lands or waters are located. Nothing in this Act shall prevent or prohibit the enforcement of regulations established by any Division of the Department within wetlands areas, provided that the Department monthly furnish to the Commission a list of all arrests, findings, and judgments made by the Department and relevant courts for violations thereof.

9. The Commission shall acquire in the name of and for the Department of Natural Resources, wetlands areas and adjacent waters for the purposes of protection, preservation, conservation, management of economic species or wildlife, or abation from unsuitable modification or alteration. Said acquisition to be by purchase, receipt of donation, or eminent domain, provided however, that the Commission shall not exercise the power of eminent domain until all other mechanisms for acquisition shall have been exhausted. The Commission in like manner, may acquire selected rights to private property (viz., air, water or mineral rights) if in the opinion of the majority of the Commission members, the purchase thereof promotes the highest and best possible use of the environment. The Commission may also allocate funds to local and regional governments and authorities desirous of preservation and protection of wetlands municipally held. For the purposes of this section the sum of ten thousand dollars ($10,000) shall be included annually in the general budget of the Commission.

10. The Commission shall cooperate and review the work of the Divisions of the Department of Natural Resources in the design, approval, construction, and upkeep of facilities in wetlands areas planned for the comfort, protection, and education of visitors present in or adjacent to said areas, for such purposes as the Department shall authorize from time to time.

11. The Commission shall employ not less than two (2) persons full time, to be engaged solely in environmental education of the public. Duties of said persons to be determined by the Chairman of the Commission in cooperation with the Director of the Department.

12. Not more than six months from the date of enactment of this act, the Commission shall authorize a study of the coastline and interior shores and waters of the state, to accurately determine and map areas which may be defined as listed in this act. The Commission shall further determine rates, types and means of wetland destruction, and within two years of the enactment of this act, shall present and publish their findings, in a form acceptable for publication and general distribution.