Abstract

Wetland mitigation banking is a market-based approach to wetland regulation that seeks to compensate for permitted wetlands losses through the creation, restoration or enhancement of wetland areas of equivalent value. Generally mitigation banks are in a centralized location outside of the area of loss. Mitigation banks are intended to compensate for lost wetland functions and values, like flood storage, wildlife habitat and water purification.

In the past fifteen years mitigation banking has gained acceptance as a valid means of satisfying compensatory mitigation requirements with the federal government and most states. More recently mitigation banks have been stimulated by the national goal of no net loss of wetlands. Some wetland regulators believe that wetlands are replicable, promising the replacement of wetland functions. This allows for the destruction of wetlands while satisfying no net loss requirements. However, there is little scientific evidence suggesting the technical feasibility of wetland replications to compensate for most lost wetland functions or even the ability to replicate most wetland types.

Rhode Island's wetland regulations are some of the strongest in the country and currently Rhode Island is one of a few states not planning to utilize any form of mitigation banking. However, there are political currents in the state suggesting there will soon be a weakening of wetland protection in the state. A recently submitted wetlands’ bill suggests that wetlands may soon be protected based upon their functions. Functional protection is a prior condition for wetland mitigation banking, because it establishes a hierarchical system of wetland protection based upon perceived functions.

Federal and state agencies have utilized mitigation banking systems as a response to the failures of on-site mitigation efforts. In Rhode Island, regulatory agencies have utilized avoidance and minimization mechanisms for wetland impacts, rarely relying on on-site mitigation. As such, Rhode Island does not have a failure of on-site mitigation efforts that would justify a move to a mitigation banking system. The state is in the position of deciding the viability of mitigation banking on it own merits, using the experience of other states.

The majority of Rhode Island's wetlands are of types that presently are the least replicable. This suggests that it would be difficult to comply with the guidelines for the use and establishment of mitigation banks outlined by the federal government. Recognizing these limitations, mitigation banking could be integrated into long-range watershed based wetland preservation and restoration efforts by addressing the functional needs of specific watersheds. Mitigation banking would, however, represent a fundamental paradigm shift in the state of Rhode Island. Individual wetlands would be protected based upon the functions that they provide to society; wetlands with limited functions potentially would be subject to destruction and attempts would be made to replicate their functions elsewhere.

Introduction

Wetland mitigation banking is a market based approach to wetland regulation which seeks to replicate wetlands to compensate for permitted wetland destruction; it has recently gained acceptance with various states and federal agencies involved in wetland management. It is part of a national trend towards the management of wetland resources based upon wetland functions. However, uncertainly remains as to whether mitigation banking can compensate for particular wetland functions lost when wetlands are destroyed.

I wrote this thesis in anticipation of the likelihood that wetland mitigation banking will be discussed in a political context in Rhode Island in the near future. Recognizing this, I evaluate the viability of wetland mitigation banking in the context of the character of the state's wetlands. Wetland resources and regulation are considered in regards to the functions which wetlands provide in the state, the technical feasibility of wetland replication science and the use of mitigation banking in the context of watershed planning.

What is Wetland Mitigation Banking?

Wetland mitigation banking is a natural resource management concept designed to provide compensation for permitted wetland losses through the creation, restoration, or enhancement of wetland areas of equivalent value, generally located outside of the immediate area of wetland loss. Mitigation banks are characteristically large blocks of replicated wetlands, to which credits are assigned. These credits may be sold to or withdrawn by impactors of wetlands to satisfy compensatory mitigation requirements of various state and federal laws. Credits may be sold or withdrawn until there are no more credits left in the bank, at which point the bank is retired and a new source of mitigation credit must be utilized. Replicated wetlands are intended to compensate for functions lost when naturally occurring wetlands are destroyed.

Mitigation banks proponents have articulated two primary advantages:

1. Mitigation Banks allow for the consolidation of mitigation sites in specially designated and managed areas.
2. Mitigation Banks generally function in advance of wetland losses.

Mitigation banks arose as an alternative to on-site mitigation of wetland impacts, which has been the dominant mitigation strategy since section 404 of the Clean Water Act first required the mitigation of wetland impacts. Many of the benefits of mitigation banking are based upon its advantages over on-site replication efforts. Generally these advantages relate to regulatory failures to monitor replicated wetlands or scientific limitations associated with wetland replication science.

In Rhode Island, the failure of on-site mitigation is not a serious consideration. Few on-site wetland mitigation efforts have been attempted because the state's regulatory system has generally prevented wetland destruction in the last 25-30 years. As such, Rhode Island is in the unique position of being able to decide whether mitigation banking should be allowed in the state, not based upon the failures of an on-site replication process but upon the experience of mitigation banking in the national context.

Current Political Climate in Rhode Island

Rhode Island passed laws protecting both fresh and coastal wetlands in 1971, and was the second state to do so. For 26 years, there has been strong legal protection of wetlands in the state. This protection has been philosophically preservationist, granting legal protection from alteration by filling. This essentially removes over 20% of Rhode Island land from development.

Recently, total permitted wetlands impacts have averaged only 15 acres per year in the state.[1] This is inconsequential in the context of annual nationwide losses. Since the majority of wetlands are on private property, there are obvious conflicts with developmental interests and property rights. This preservationist philosophy is viewed by some as anachronistic in the national context of wetland management.

The Department of Environmental Management (DEM) has recently come under severe criticism, with the wetland permitting programs being particularly censured. In a recent poll of 900 Rhode Islanders who sought permits from the DEM, 63% reported the wetlands permitting process as "totally frustrating" and another 42% reported that the wetlands staff at the DEM were "unprofessional".[2] Part of the animosity towards the DEM is the result of its strict adherence to the preservationist philosophy mandated under the Freshwater Wetlands Act.

A legislative commission (called the Kennedy Commission after Brian Kennedy, D-Hopkinton, its chair) began holding hearing on the DEM in the fall of 1996. This commission has been extremely hostile to the DEM. Louise Durfee, a former DEM Director, called the commission "an unfocused witch hunt with members who have a vendetta against the department". The DEM has been accused of being a needless bureaucracy and denying citizens use of their property. House Majority Whip, Suzanne Henseler, a commission member, stated: "what I've found is that people are totally frustrated in their dealings with DEM." [3]

---

[1] See footnote 17.

[2] Providence Journal-Bulletin, 2/5/97

[3] Providence Journal Bulletin. 2/16/97

The DEM has other problems. In last two years, DEM has lost 35 employees and suffered 10% budget cuts. John P.DeVillars, EPA's Region I administrator, warned Governor Almond in February of 1997 of "grave concerns regarding the ability and capacity of DEM to effectively administer federal environmental laws and regulations in Rhode Island".[4] The EPA administrator threatened to revoke the state's authority to carry out elements of the Clean Water Act (CWA) unless the state increased its spending on water pollution programs.

It was in this political climate that a Freshwater Wetlands Bill was introduced in the 1996 Legislative Session of the Rhode Island General Assembly. A committee of "stakeholders" appointed by the Governor had written the Bill. The bill failed in general session but will be reintroduced in the 1997 session. Elements of the bill suggest it is only a matter of time before wetlands in the state are rated by function. Rating wetlands by function is a step towards a hierarchical system of protection and implies that mitigation banking could be seriously discussed in the near future in Rhode Island.

Structure of the Thesis

In the first two chapters, I address the wetland resources of the state. Chapter one discusses the wetlands of Rhode Island in terms of legal protection, current pressures and historical losses of wetland resources. I articulate the philosophical shift that may be occurring in the state, suggesting that mitigation banking soon will be discussed in the state. In chapter two, I discuss the functions that wetlands provide to Rhode Island. Barriers to the economic valuation of wetlands are explained, recognizing that many wetland functions like flood storage or water quality improvement are public goods.

[4] Providence Journal Bulletin. 2/5/97

Chapter two points out that wetland regulations often pit public goods against the economic interests of the individual property owners upon whose land wetlands are located.

In chapter three, I explain the regulatory context in which mitigation banking occurs in the United States and the primary federal legislation regulating wetland resources, the Clean Water Act (CWA). I examine the evolution of mitigation requirements, some fundamentals of mitigation banking mechanisms, the spread of mitigation banking and state mitigation banking mechanisms and, the nature of the evolution of compensatory mitigation are discussed.

Chapter four deals with the scientific and technical limitations of mitigation banking, in the context of Rhode Island's wetland types. The scientific evidence that suggests that most wetland types and functions are replicable is discussed. I conclude that the establishment of a mitigation banking system in the state of Rhode Island based upon the Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, is not presently feasible.

Recognizing these limitations, in chapter five I examine possible mitigation banking mechanisms in the state of Rhode Island and particularly how mitigation banking could be integrated into long range watershed based wetland preservation and restoration efforts by addressing the functional needs of specific watersheds.

Federal and state wetland laws are designed to protect the function and values which wetland ecosystems provide; associated compensatory mitigation requirements are designed to compensate for lost wetland functions and values that result from unavoidable impacts. Proponents of wetland replication believe that wetlands are a renewable and replaceable resource. This is part of a human-nature relationship "dominated by an implicit faith in perpetual progress" which believes that "ecological problems can be avoided by applying to our problems more science and technology".[5]

Mitigation banking is an experiment in which forty-three states are participating. Rhode Island is in the position to decide what, if any, role it will have in this experiment. In this thesis, I seek to illuminate the issue of whether wetland mitigation banking should be allowed in the state of Rhode Island.

Chapter One: Wetland Resources and Regulation in Rhode Island

Rhode Island's protection of its wetlands is one of the strongest in the country; all wetlands are protected equally. This is in contrast to a national trend away from strict

[5] White, Lynn.1968. Origins of our Ecological Crisis. Science

protection of wetlands and towards a protection of wetlands based upon functions. For example, in Ohio, officials are considering new water-quality standards that would categorize the state's wetland areas and provide different levels of protection for each category. The current rules protect all wetlands equally, whereas the new rules would rank wetlands in three categories according to such factors as "the number of species they contain, whether they have become overrun with non-native species, and the importance of their water filtering and flood-controllabilities."[6]

A recently submitted Wetlands Bill suggests that Rhode Island may be moving towards a hierarchical system of wetland protection based upon functions. This is a step towards mitigation banking.

Wetland Definitions

The term "wetland" was not commonly used in the United States before 1972 and the attempt to define a wetland has been controversial and confusing. This controversy has increased as regulatory protection of the wetlands of the United States has been strengthened. Before Rhode Island passed its wetland's law in 1971, and the federal government asserted greater control over wetland resources through Section 404 of the Federal Water Pollution Control Act of 1972, there was no legal reason to define wetlands. The first serious attempt to define wetland types was the U.S. Fish and Wildlife's Classification of Wetlands and Deepwater Habitats of the United States (1979).

There are, at present, at least five definitions of wetlands which regulatory bodies are using in Rhode Island. All largely overlap but slight differences exist. Generally, the

---

[6] Randall Edwards. COLUMBUS DISPATCH, 11/25.

focus of wetlands' definition will depend upon the interests of those making the definition. Wildlife biologists will tend to define wetlands based upon the animal species present, while a botanist or hydrologist will focus upon plant or soil types respectively. Further, there are differences between ecological and regulatory definitions of wetlands. Controversy surrounding definitional issues has been so intense that the U.S. Congress in 1993 asked the National Research Council (NRC) to establish a scientific basis for the characterization of wetlands. Below are five wetlands definitions used by the five regulatory bodies that are involved in the management of Rhode Islands wetland resources (also included is the National Research Council's reference definition).

Table 1.1. Definition of Wetlands by Different Federal and State Agencies[7].

Organization	Definition	Comment
U.S. Fish and Wildlife Service[8]	Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.	The FWS definition stems from a 1979 report by Cowardin et al . which was used to conduct the National Wetlands Inventory (NWI)[9]. This definition emphasizes the three ecologically key attributes.[10] The FWS definition was specifically not intended to provide a legal definition of wetlands, recognizing that other federal and state agencies will determine what is or is not legally a wetland.

[7] Adapted from Tiner, Ralph W.,.1989. Wetlands of Rhode Island. U.S. Fish and Wildlife Service, National Wetlands Inventory, Newton Corner, MA. 71 pp. + Appendix

[8] Cowardin, et al. 1979.

[9] The FWS service began mapping the wetlands of the U.S. in the 1970s, and the process is still in progress. The NWI project is for resources assessment, not regulation. The NWI has mapped most of New England, all of RI.

U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency[11]	Wetlands are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions. Wetlands generally include swamps, marshes, bogs and similar areas."	The Corp's definition emphasizes hydrological conditions as the basis for determination of wetland presence. The definition also includes references to vegetation that is adapted to saturated soil types, but makes no reference to actual soil types. This definition is also used by the EPA, and originally was promulgated to comply with Section 404 of the Clean Water Act of 1977[12].
Natural Resources Conservation Service[13]	Wetlands are defined as areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophylitic vegetation typically adapted for life in saturated soil conditions, except lands in Alaska identified as having high potential for agricultural development and a predominance of permafrost soils.	The Natural Resource Conservation Service (NRCS, formerly the U.S. Soil Conservation Service) definition is based upon the Food Security Act (FSA) of 1985 "Swampbuster" provision[14] ,which emphasizes hydric soil as a central criteria for wetland status. The FSA was designed to prevent farmers who were converting wetlands to agricultural uses from obtaining government benefits like loans or payments. The FSA definition has been criticized because while most

[10]Tiner, Ralph W. 1989.

[11]42 Fed. Reg. 37, 125-26, 37128-29; July 19,1977

[12]Clean Water Act, 33 U.S.C. 1251-1387; 33 U.S.C. 1319

[13]National Food Security Act Manual.1988.

[14]Food Security Act (FSA) (P.L. 99-198, 99 Stat. 1504)

		wetlands do contain hydric soils, some do not.[15]
National Research Council[16]	A wetland is an ecosystem that depends on constant or recurrent shallow, inundation or saturation at or near the substrate. the minimum essential characteristic of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical and biological features reflective of recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophyltic vegetation. These features will be present except where specific physiochemical, biotic, or anthropogenic factors have removed them or prevented their development.	The Committee on Wetlands Characterization definition was developed to be broad and inclusive. It explicitly refers to the ecosystem conception of wetlands, recognizing the critical hydrological element of wetlands. Much like the FWS definition, it is specifically designed not to be a regulatory definition.
State of Rhode Island Coastal Resource Mgmt. Council[17]	Coastal wetlands include salt marshes and freshwater or brackish wetlands contiguous to salt marshes. Areas of open water within the coastal wetlands are considered a part of the wetland. Salt marshes are areas regularly inundated by salt water through either natural or artificial watercourses and where one or more of the following species predominate: {9 indictor species listed}. Contiguous and associated freshwater or brackish marshes are those where one or more of the following species predominate: [8 indicator species listed].	The CRMC's policy on coastal wetlands is largely derived from hydrological connection to salinated water and the presence of indicator species. Coastal wetlands are easier to define because of their close proximity to sea and the relatively small diversity of their plant species.[18] Finally, the CRMC definition is also constructed to determine jurisdictional boundaries.

---

[15]National Research Council

[16]National Research Council , p. 57

[17]RI Coastal Resources Management Program, other wise known as the Red Book.

[18]Skisler, Joseph K. .1990. Creation and Restoration of Coastal Wetlands of the Northeastern United States. In. Wetlands Creation and Restoration: The Status of the Science Eds. Kusler and Kentula.

State of Rhode Island Department of Environmental Management	Freshwater wetlands are defined to include but not be limited to marshes; swamps; bogs; ponds; river and stream flood plains and banks; areas subject to flooding or storm flowage; emergent and submerged plant communities in any freshwater including rivers and streams and that area of land within fifty feet of the edge of any bog, marsh or swamp. Various wetland types are further defined on the basis of hydrology and indicator plant species, including bog (15 types of indicator plants), marsh (21 types of plants) and swamp (24 types of indicator plants plus marsh plants).	The DEM definition was promulgated under the authority the Fresh Water Wetlands Act[19]. It defines wetland based upon hydrology, proximity to flowing water and indicator plant species. Of special note is the inclusion of buffer zones around aquatic resources as legal wetlands.

The six wetlands' definitions listed above are all designed for different purposes. These definitions are included primarily for the purpose of demonstrating that in the field of wetlands, the most fundamental decision as to what a wetland is has yet to be settled. For the remainder of this thesis, the primary definitions of wetlands of concern will be DEM's, CRMC's and the Corps'. These would be the primary regulatory agencies involved with wetland mitigation banking. For the purposes of this thesis, it can generally be stated the DEM and CRMC definitions of wetlands are the broadest. As such, anything that other regulatory agencies consider to be wetlands, DEM and the CRMC would consider to be wetland. The reverse, however, is not true.

History

Only in the past thirty years have the economic and ecological values of wetlands been understood. Prior to the mid-1960s and early 1970s there was no legal protection

[19]Freshwater Wetlands Act, 2-1-18 through 2-1-24, inclusive, of the General laws of 1965. as Amended. (here after, the Act)

for the nation's wetlands, with the federal government encouraging the conversion of wetlands to "higher uses" through the various Swamplands Acts of 1849, 1850 and 1860. These Acts gave over 60 million acres of federal land to 15 states for conversion to agricultural uses. However, the vast majority of wetland impacts were the result of individual actions upon private property.

Dahl (1990) estimated that at the time of European colonization of the Continental United States, there were some 200 million acres of wetlands (approximately nine percent of the land). Wetlands were desirable for agrarian purposes because of their rich hydric soils and characteristic levelness. Other wetlands were drained for public health reasons, since wetlands are associated with diseases like malaria and typhoid. Between 1780 and 1980, one half of the wetlands in the Continental United States were converted to other land uses. From the mid-1950s to mid-1970s, the annual average loss was over 550,000 acres per year. Map 1.1, Appendix A shows the estimated historic losses of wetlands in the continental United States.

A majority of the historic conversions of wetlands were for agricultural proposes. In several historically agrarian states like Ohio, conversion rates exceed 90%. The types of wetlands in Ohio, Illinois and other mid-western states were easily converted to croplands. Rhode Island's conversion history is different.

Rhode Island's Wetland History

Dahl (1990) estimated that Rhode Island lost 37% of its wetland from 1780-1980, reducing wetlands from 102, 690 acres in 1780 to 65,154 acres in 1980. These estimates of historic wetlands losses were made by comparing the presence of hydric soils on USGS soil survey maps to the National Wetland Inventory (NWI) data. Places with hydric soils and no wetlands were assessed as being historic areas for wetlands.

Frank Golet, a Professor at the University of Rhode Island and a national authority on wetlands, believes that the Dahl data are flawed for Rhode Island. First, Golet asserts that many of Rhode Island's wetlands were lost to urbanization and development. The Dahl method used the USGS soil survey conducted in 1975, and this survey would not show hydric soils in many urbanized areas. For instance, much of Providence's South Main Street is built upon historic wetlands. South Main Street was not included in the Dahl study because there is no way to characterize soil types in Providence. After hundreds of year of anthropogenic manipulation, characterization of Providence soil types is difficult. This is just one example of a statewide problem.

Further, Golet maintains that the NWI did not include much of Rhode Island’s forested wetlands because of limitations in its method. He believes that Rhode Island's wetlands' losses should be closer to Connecticut's. Connecticut's historic losses are estimated at 74%. Prof. Golet's assertion seems valid, given the similarities of topography and land use history in the two states.

Since Rhode Island is the second most densely populated state, recent wetland losses have largely been associated with population expansion, not agriculture. In an assessment of wetlands' losses from 1939-1972, highway construction and residential development were the leading causes. However, Marks (1989) reported that no systematic study of permits issued by the DEM Freshwater Wetlands Division has been conducted since 1971.[20] Extensive development has occurred since then.

Wetlands of Rhode Island

There have been two major attempts to map the wetlands of Rhode Island. The first was the NWI, using mid-1970 data. The NWI minimum mapping unit was 1 acre, any wetlands under this size were not mapped. According to the NWI, in Rhode Island there are 65,000 acres of wetlands, out of 677,120 total acres. This figure excludes wetland areas around rivers and streams that are included in the DEM definition of wetlands.

The DEM and the University of Rhode Island mapped the wetlands of Rhode Island, using the definition of wetlands established by the Freshwater Wetlands Act. Table 1.2 and Map 1.2 , Appendix A show the wetlands of the state.

[20] Marks, Eugenia.1989. A Case Study in Environmental Policy: Administration of the Rhode Island Freshwater Wetlands Act. Master Thesis, Center for Environmental Studies, Brown University.

<u>Table 1.2 Rhode Island Geographical System (RIGIS) Wetland Acreage for Rhode Island</u>

Wetland Type	***Acres***	***Percentage of Total***
Riverine Nontidal Open Water	1,716	1%
Lacustrine Open Water	17,943	6%
Palustrine Open Water	3,839	1%
Emergent Wetland: Marsh/ Wet Meadow	4,199	1%
Emergent Wetland: Emergent Fen or Bog	225	0%
Scrub-Shrub Wetland: Shrub Swamp	9,162	3%
Scrub-Shrub Wetland: Shrub Fen or Bog	1,945	1%
Forested Wetland: Coniferous	10,782	3%
Forested Wetland: Deciduous	60,474	19%
Forested Wetland: Dead	213	0%
Riverine Tidal: Open Water	50,132	16%
Estuarine Open Water	98,622	31%
Marine/Estuarine Rocky Shore	658	0%
Marine/Estuarine Unconsolidated Shore	2,883	1%
Estuarine Emergent Wetland	52,498	17%
Estuarine Scrub-Shrub Wetland	93	0%
Total Wetlands	315,383	100%

For the remainder of this thesis, deepwater habitats will be excluded from discussion. Excluding the deepwater habitats of Riverine Tidal and Nontidal, Riverine Open Water, Lacustrine Open Water, and Estuarine Open Water, there are 146,907 acres of wetlands in the state, or 22-24% of the states land area.

Current Pressures

The rate of filling Rhode Island's wetlands has largely abated with the passage of federal and state laws that prohibit the wholesale destruction of wetland resources. However, some wetland fills still occur. In the years 1994 through 1995, the DEM issued permits to fill 29.42 acres.[21] Such losses are insignificant when considered in the national context. Estimates of wetland losses yearly in the United States after passage of the Clean Water Act have averaged about 300,000 acres per year.[22]

In Rhode Island, the current pressures on wetlands are upon functioning, since the state is effectively protecting its wetlands from conversion. Functional assessments of wetlands are critical to the conception of mitigation banking, since mitigation banking seeks to replace functions lost by conversion. A mitigation banking system in Rhode Island would shift the regulatory focus from protection of individual wetlands to the protection of wetland functions. This is the heart of the paradigmatic shift that is a part of wetland mitigation banking, the shift from concern of conversion to functioning.

No studies have been conducted assessing the overall ecological functioning of Rhode Island's wetlands and there is no system in place for the DEM to record the cumulative effects of authorized wetland impacts. Therefore, assertions regarding the overall functioning of the state's wetlands must be based upon two methods: land use patterns and studies of functional impacts on individual wetlands in Rhode Island and other states. Since mitigation banking is concerned with wetland functions, an

[21] Permits were tracked through the *Regulatory Reporter*, published by Coastwise, which reports all permits issued by CRMC and RI DEM.

[22] Want, William L. 1989. *Law of Wetlands Regulation* Section 2.01 (3)

understanding of the present state of the functioning of Rhode Island's wetlands is essential.[23]

Land Use Pressures

Rhode Island is the second most densely populated state in the country, with a density of 958.2 people per square mile in 1992.[24] The overwhelming majority of population growth in the state since 1960 has taken place in non-urban areas, most notably in towns like Charlestown, Coventry, Exeter, Glocester, Jamestown, Narragansett, Richmond, and West Greenwich.[25] These population shifts have resulted in a land use pattern characterized by very low-density development. Resulting road building and housing construction have been associated with wetland losses.[26] While much low-density development may not have resulted in the direct filling of wetlands, such development certainly has impacted wetland functioning.

The impact of a house in a sparsely developed section of Exeter or Hopkinton goes beyond the land upon which that house sits. Suburban land use requires roads, powerlines, gas pipelines and other linear development impacts that fragment and disturb wetlands. The construction of I-95 and other roads has facilitated this trend, as I- 95 and other major roads enable Rhode Islanders to live farther from employment centers.[27]

---

[23] Desbonnet, A. and V. Lee .1991. *Historical Trends, Water Quality and Fisheries, Narragansett Bay*. The University of Rhode Island Coastal Resource Center. Contribution No.100 and National Sea Grant Publication #RIU-T-91-001, Graduate School of Oceanography, Narragansett, RI 101pp.

[24] U.S. Census adjusted data 1992.

[25] *1990 Nationwide Personal Transportation Survey.* (NPTS) U.S. Department of Transportation. Prepared by U.S. Bureau of the Census.1990.

[26] Golet and Parkhurst .1981.

[27] Ibid.

Between 1980-1990 Rhode Islanders increased their Average Vehicle Miles by over 30%.[28] As a result, the Rhode Island Department of Transportation is one of the larger impactors of wetlands in the state.[29] No comprehensive study of the effects of low-density development upon Rhode Island's wetlands has been conducted. However, it has been estimated by the RI DEM that 20-30% of Rhode Island's 140,000 Individual Sewage Disposal Systems (ISDS) are failing.[30] ISDS that are within 300 hundred feet of a wetland have been reported to alter the natural growth patterns by phosphate and nitrate loading.[31] This can lead to the preponderance of invasive species like phragmites thus the reduction of biodiversity. Most of these ISDS are in low-density development areas where the states greatest wetland resources are located.

Development in these rural and suburban areas has also resulted in fragmentation and isolation of many of the state's wetlands. Fragmentation has been reported as causing the greatest harm to Rhode Island's forested wetlands,[32] impacting a variety of functions including wildlife habitat. Forested wetlands account for 75% of Rhode Island's wetlands.[33]

---

[28] *1990 Nationwide Personal Transportation Survey*.

[29] 7.6 acres since 10/95

[30] Governor's Advisory Committee on Wetlands and Septic Systems. Final Report. December 1995.

[31] Adamus, Paul .1986. The Cumulative Impacts of Development in Southern Maine: Wetlands, Their Locations, Functions, and Value. Maine State Planning Office.

[32] Enser, Richard .1988. "Wetlands Amendment," Ocean State Outdoors, Recreational and Conservation Strategies for Rhode Island. Division of Planning and Development, RI Department of Environmental Management.

[33] RIGIS

Development and resulting fragmentation have been associated with impacts to wetland functions like flood storage and wildlife habitat.[34] As such, there is little doubt that continued low-density development is impacting wetland functions. Non-point sources of pollution associated with ISDS are also causing impacts. While total wetland loss in the state is now low, the land use pattern strongly suggests wetland functions are being degraded. Wetland functions and values will be discussed in detail in the next chapter.

Coastal Wetlands

In a study conducted by Tiner (1984)[35] in California, New Jersey, and New York, it was estimated that urbanization was responsible for 90% of coastal wetland losses. In Rhode Island, it has been estimated that 50% of Rhode Island's salt marshes 40 acres or more in size have been lost to development.[36] Further much of downtown Providence and Quonset Point were built upon filled wetlands.[37] As of 1975, there were some 3,700 acres of remaining coastal wetlands in Rhode Island.[38] While there is much uncertainty surrounding coastal wetland loss in Rhode Island, simple population and industrialization

---

[34] Balter, R. 1994. Procedure to Predict the Impact of Hydric Modifications by Highways on wetlands (Interagency Agreement with U.S.G.S.) FHWA-USGS Contr. No. 83-Y-10063. Diaog Agu No. 388609. Kobriger, N.P. Effects of Highway Runoff on Wetlands. Final Report. National Cooperative Highway Research Program Report. No. 264. 353 pp.

[35] Tiner, R.W. 1984. Wetlands of the Untied States: Current Status and Recent Trends. National Wetlands Inventory Project. Washington, D.C. : U.S. Fish and Wildlife Service.

[36] U.S. Fish and Wildlife Service Wetlands Inventory .1960.

[37] Narragansett Bay Method: A Manual for Salt Marsh Evaluation. 1996. Save the Bay

[38] Halverson, W.L. and Gardiner, W.E. .1976. Atlas of Rhode Island Salt Marshes. University of Rhode Island Marine Memorandum No.44

patterns along the shoreline of the state suggest that coastal wetlands have been severely altered by anthropogenic activities.

Current Rhode Island Wetland Laws and Regulations

Rhode Island has one of the strongest sets of laws for the protection of wetlands in the country. It was the second state to pass legislation protecting both fresh and coastal wetlands in 1971.[39] All wetlands in the state are protected from non-approved conversions. As stated earlier, in the years 1994 through 1995, permits were issued to fill only 29 acres of wetlands. In other states, 15 acres of permitted wetland fill per year would be considered insignificant. Under the Corps definition of wetlands, only 9.69 acres of those 29 acres are regulated as wetlands.[40] Much of the total impacts of 29 acres were impacts upon buffer zones surrounding wetlands, rivers and streams.[41]

Responsibility for the regulation of wetlands in the state is divided between the DEM and the CRMC. The DEM, Division of Freshwater Wetlands, has regulatory authority over the freshwater wetlands of Rhode Island through the Freshwater Wetlands Act. The CRMC has regulatory authority over coastal wetlands, which include salt marshes and “freshwater wetlands located in coastal vicinities”.[42] Presently, negotiations between the regulatory agencies are in process to determine those freshwater wetlands in the coastal vicinities that will be under jurisdiction of the CRMC.

Freshwater Wetlands

---

[39] Rhode Island General Laws 2-1-18 through 2-1-27.

[40] Presently, under the Nation Wide Permit (NWP) 26, discharge of dredged or fill material into less then one acre of wetlands may be filled without notification of the Army Corps.

[41] Telephone interview with Charles Hobert of DEM Division of Groundwater and Freshwater Wetlands.

[42] Rhode Island General Laws 20-10-1 through 20-10-4 .1996. entitled “Aquaculture”.

Permits to alter freshwater wetlands are processed by the DEM Division of Freshwater Wetlands. Activities that require a permit under the Freshwater Wetland Act defined as:

> RI Gen. Laws @ 2-1-21 (1956) as Amended 1995.
> No person, firm, industry, company…may excavate, drain, fill, place trash, garbage, sewage, highway runoff, drainage ditch effluents, earth, rock, borrow, gravel, sand, clay, peat, or other materials or effluents upon; divert waters flows into or out of, dike, dam, divert, change, add to or take from or otherwise alter the character of any freshwater wetland herein defined without first obtaining the approval of the director of the department of environmental management.

Further, activities that occur outside of freshwater wetlands that are likely to alter the natural character of any freshwater wetland require a permit from the director. These activities include increases in impervious surfaces, modification of run-off that permanently modifies significant vegetative cover on areas draining to freshwater wetlands, and modifications to the quality of water reaching freshwater wetlands that could change their natural character. [43]

The first step in the permitting process is to determine the presence of a wetland(s).[44] If a wetland is involved in the project, the next step is an application for a preliminary determination.[45] Projects that are deemed to pose insignificant alteration on a freshwater wetland will be issued a permit called FONSI (Finding of No Significant

---

[43] Rules and Regulations. 7.01.B

[44] Rules and Regulations. 9.02

[45] Rules and Regulations. 7.02

Impact).[46] Table 1.3 summaries data from the application process to the DEM for the years of 1993 and 1994.

Table 1.3 Summary of Application Processing Statistics for 1993 and 1994[47]

Permit Process	**1993**	**1994**
Preliminary determination of presence of wetland	489	476
Permits issued as insignificant alteration	411	354
Determination that project represents a significant alteration	50	54
Determination that project is not under DEM jurisdiction	28	17

[46] Rules and Regulations 5.42 Insignificant Alteration means, in the opinion of the director, a proposed alteration, limited in scope, areas and/or duration, which appears to result in no more than a minimal change or modification to the natural characteristics, functions, and/or values of any freshwater wetlands(s), and is not random, unnecessary and/or undesirable.

[47] Provide by DEM to Governor's Commission on ISDS and Wetlands

Technical Deficiencies found in Preliminary Determinations	303	Not Available (NA)
Formal Application to alter freshwater wetlands	40	34
Permits Issued	23	15
Permits Denied	3	12
Contested cases resolved through settlement	7	8
Cases adjudicated	1	0
Administrative penalties and fees	NA	$72,441
Wetlands ordered restored	NA	80
Cases referred for Prosecution	NA	1

The DEM Division of Freshwater Wetlands has a strong preservationist philosophy and relies on its legislated authority to assure that almost all-freshwater wetlands are preserved. Most impacts which are permitted in the state are those deemed to be a public good, like road building.

Coastal Wetland

The CRMC "Red Book"[48] has strong policies recognizing both the historical loss of the State's coastal wetlands and the impacts that land use activities abutting coastal wetlands have on their ecological functions. Table 1.4 shows the CRMC's Water Types:

Table 1.4 CRMC's Water Types

USE TYPE	WETLAND REGULATION	EXAMPLE
Type 1. Conservation	All commercial development is	Much of the South

[48]The State of Rhode Island: Coastal Resources Management Program. 1977. As Amended.

Areas In these areas the CRMC's goal is to preserve and protect waters and contiguous land from "activities which degrade scenic, wildlife, and plant habitat values, or which may adversely impact water quality and the diversity of natural shoreline type"	prohibited, along with dredging and disposal of dredging materials. All alterations to coastal wetlands contiguous with type 1 waters are prohibited, except for structural alterations associated with conservation and natural storm buffers.	County's Shoreline, like Napatree Point, bluffs and cliffs of Block Island and part of Newport's shoreline
Type 2. Low Intensity In these areas high quality ecological waters co-exist with low intensity recreational uses and residential development.	All alterations to salt marshes and contiguous freshwater or brackish wetlands abutting Type 2 waters are prohibited except for minor alterations associated with residential docks and walkways[49].	Much of Watch Hill, Misquamicut and Judith Point .
Type 3. High-Intensity Boating - These are areas characterized by high intensity recreational boating and associated marinas and boat yards.	Certain coastal wetlands designated for preservation adjacent to Type 3,4,5 and 6 waters, only alterations described above under Type 2 allowed. Generally wetlands larger then one half acre. However, all wetlands in coastal area protected by DEM.	Pawtuxet Cove, Apponaug Cove in East Greenwich, parts of Sakonnet River
Type 4. Multipurpose Waters These areas support high intensity recreational activities, water dependent commercial and industrial activities.	Same as Type 3.	Most of Narragansett Bay and the Sound .
Type 5. Commercial and Recreational Harbors. These areas support both recreational and commercial activities.	Same as Type 3.	Most harbors in the State are Type 5, including Newport, Bristol and Watch Hill Harbors
Type 6. Industrial Waterfronts and	Same as Type 3.	The Port of Providence, Quonset Point,

Commercial Navigation Channels. These areas are the primary industrial zones and associated water-dependent access points which characterize much of the State's industrial economy.		Davisville and Westerly's waterfront.

These policies are intended to result in strong environmental protection of Rhode Island's coastal wetlands. Almost no coastal wetlands are legally filled at present, except for rare exceptions. For example, in 1994 the Misquamicut Golf Club in Watch Hill received permission to fill 3.99 acres of coastal wetlands,[50] from DEM and CRMC.[51] This filling, however, is part of a project that will restore 16 acres of coastal wetland, and thus will produce a net gain of 12 acres.[52]

The CRMC's use classifications represent the status quo of coastal development at the time of promulgation of the CRMC's Red Book in 1977. Water types were designed around development existing in the early seventies. While the outright filling of coastal wetlands has abated, little in the Red Book addresses the continuing deleterious effects to wetlands still occurring where previous coastal development had taken place.[53] As with freshwater wetlands, pressures upon coastal wetlands are now largely the result of fragmentation and chemical stressors associated with ISDS and runoff from imperious surfaces.

---

[50]DEM permit #94-0592

[51]Joint jurisdiction over freshwater coastal wetlands.

[52] Whether this net gain in acreage is also a net gain to wetland functions in the state is at the center of the debate over wetland mitigation.

[53] and grandfathered zoning

The permitting process for the CRMC is similar to the DEM's. However, there is one critical difference. The DEM's professional staff makes permit decisions whereas as the CRMC's professional staff makes recommendations on permit decisions to the politically appointed Council.

Proposed Changes to Wetlands Law

In the 1996 Legislative Session of the Rhode Island General Assembly, amendments to the Freshwater Wetlands Bill[54] were introduced, based on the recommendations of the Governor's Advisory Committee on Wetlands and Septic Systems. This committee was made up of "stake holders" interested in wetlands and septic issues in the state. Members included representatives from Save the Bay, RI Audubon, RI's agricultural community, developers and regulators. The bill failed in general session but will be reintroduced in the 1997 session. It is generally considered that the bill failed not based upon its merits but because of unrelated conflicts between the governor and state legislature.[55] This bill, if passed, would represent a fundamental paradigm shift in Rhode Island's dealings with its wetland resources.

The Bill include a number of changes in wetland regulation, including:

- A redefinition of significant impact so that the filling of less than 4,000 square feet (s.f.) would be a FONSI.[56] DEM would have veto power over special or rare wetlands like vernal pools of less than 4000 s.f.
- Development of a licensing program within DEM enabling private professionals to certify or delineate the location of wetlands.
- The redefinition of buffer zones along intermittent stream from 200 feet to 100 feet.
- Increased fines for illegally altering wetlands and a possible 30 days in jail.

---

[54] 1995 RI S.B. 3142

[55] Peers communication with Xena Huff, who observed Governor's Advisory Committee meetings.

[56] Finding of No Significant Impact

The content of the bill was decided through a negotiation process where stakeholders reached consensus on key issues regarding the proposed wetland bill. Certain issues on the original agenda were left out of the bill to achieve consensus, these include:[57]

- Development of standards to allow or facilitate restoration, enhancement and replacement of wetlands where appropriate and feasible.
- Development of specific criteria to identify those wetlands that are capable, even with sound management, of performing only limited wetland functions so that activities in such areas can be permitted without undergoing an extensive review process.
- Expansion of the number of exempt activities.[58]

While the bill failed, the fact that the committee agreed that impacts less than 4000 s.f. could be considered to be FONSI's suggests that Rhode Island's wetland protection is going to be relaxed in the near future. It seems that the pro-environmental interests on the Governor's committee allowed for the inclusion of the 4000 s.f. exemption in return for the tabling of mitigation issues and of the exemption of wetlands which are perceived to be serving limited wetland functions. The circumstances surrounding this Bill suggest that it is only a matter of time before wetlands in the state are rated by their abilities to serve particular functions. Rating wetlands by function is the first step towards a hierarchical system of protection. Wetlands serving limited functions are more difficult to protect for regulatory and political reasons. Further, once functions have been assessed, the trading of functions becomes much easier. Wetland mitigation will be seriously discussed in Rhode Island in the near future.

Mitigation Requirements

[57] Peers communication with Xena Huff.

[58] Governor's Advisory Committee on Wetlands and Septic Systems: Final Report, December 1995.

Generally, there are few mitigation requirements by the DEM for wetland impacts because of the agency's utilization of avoidance and minimization techniques. So few wetlands are filled or directly impacted that mitigation is rarely a consideration. Presently, there are no DEM regulations requiring mitigation. The CRMC's policies encourage efforts to create and restore coastal wetlands.[59] However, since the filling of wetland is prohibited, mitigation procedures are rarely an issue.

There has been some mitigation required in Rhode Island, generally associated with DOT projects in conjunction with the Corps.[60] One such compensatory wetland creation project was conducted as part of the federal and state permit requirements for wetland impacts associated with construction of the Woonsocket Industrial Highway. Three freshwater wetland replication areas were constructed in 1989, establishing approximately 6.7 acres of replicated wetlands.[61]

Presently, the DOT is involved in an off-site compensation mitigation project to make up for loss caused in construction of the Jamestown Bridge by restoration of a salt marsh in Galilee, RI. [62] Some 70 acres of salt marsh are to be restored over the next ten years to mitigate damages caused by the construction of the Galilee escape road built after hurricane Carol in 1954. The escape road blocks the flow of salt water into the marsh, causing the marshes to become saturated with freshwater and dominated by

---

[59]Section 210.3. Coastal Wetlands: C. Policy #6. Red Book

[60] Since 10/95 three wetland mitigation projects have been under taken by DOT as part of permit conditions. 1: Route 138, 02 acres of wetland created to offset 0.7 acres of wetland (part of Jamestown Bridge Project) 2: Route 138, Jamestown. 3.2 acres created with 50 acres of upland preserved and given to Nature Conservancy. 3: Seapowet Bridge, 0.10 acres created (total failure) for 0.10 acres of impact.

[61]Woonsocket Industrial Highway/ Route 99 : Wetland Replication Monitoring. Prepared by Vanasse Hangen Brustlin, Inc.1989.

[62] Providence Journal Bulletin: Work Begins to Revive Salt Marsh in Galilee. 10/16/96

phragmites. The DOT destroyed 7/10th of an acre of phagmites wetlands to build the new Jamestown Bridge.[63] As part of the permit terms, the Corps ordered the DOT to mitigate impacts by creating an analogous wetland somewhere near the site. Since no site was available, the DOT has contributed $748,500 to the $1.8 million project to restore the Galilee marsh. Other contributors include Ducks Unlimited and the Corps.[64]

Mitigation Banking in Rhode Island

Mitigation banking would represent a fundamental shift in Rhode Island's attitude towards its wetlands. However, the trend towards the trading of wetland resources is already occurring. As the stalled wetlands bill demonstrates, there are forces in Rhode Island moving towards valuations in wetlands based upon perceived functional analysis. This is part of a national trend towards mitigation banking and the related philosophical view of wetland functions. The preservationist attitude of the DEM is increasingly a rare stance in wetland regulation.

Wetland resources in Rhode Island will continue to be under pressure for conversion to "higher" use. While the State's population has not increased significantly since 1980, there have been over 62,000 new houses built in Rhode Island since 1980.[65] Compound this with the facts that Rhode Island is the second most densely populated state and that over 20% of its landscape is effectively excluded from development by wetland regulations, there can be little doubt that wetland mitigation will be seriously

---

[63] DEM Permit # 86-0655F

[64] Pro Jo. 10/16/96

[65] U.S. Census adjusted data.1992.

considered in Rhode Island in the near future. The rest of this thesis will consider the feasibility of wetland mitigation banking in Rhode Island.

Chapter Two: Wetland Functions

Wetlands serve a myriad of functions to society, most of which are public goods: storing flood waters and protecting property, maintaining and improving water quality, processing both chemical and organic waste, producing a wealth of natural products.[66] This chapter articulates wetland functions in the context of Rhode Island.

[66] Many attempts have been made to place values on wetland functions and related wetland outputs. For instance the National Audubon estimated that the wetlands of the United States provide $25 billion to the national economy in 1991. Wetland outputs include the harvest of timber, shell fish, peat, cranberries and wild rice, as well as recreational opportunities associated with bird watching, canoeing, hunting, and fishing. Audubon, further suggested that wetlands directly provide one million jobs to the economy. National Audubon Society, *Valuing Wetlands: The Cost of Destroying America's Wetlands*, 29 (Deanne Kloepfer ed., 1994)

The term function is used in most literature relating to wetlands, but this term is generally poorly defined and nebulous. In this thesis, the terms used will be wetland "attribute" and "function".[67] Attribute will refer to what the National Resource Council used to define "function", as "all process and manifestations of processes that occur in wetlands". Function will be defined as a socially constructed value placed upon a wetland attribute(s).[68]

There are many barriers to the economic valuation of wetland functions. As with many environmental resources, markets do not accurately reflect the values that wetlands provide to society at large. As such, many of these functions have been undervalued by society. Further, until thirty years ago, wetland functions weren't recognized. This was either because they were not understood or abundance reduced their value. Values are placed on wetland functions when functions become scarce or when wetland destruction is imminent.

Wetland Functions in the Context of Mitigation Banking

As stated previously, nationally there is a trend towards a hierarchical protection based upon perceived wetland functions.[69] Mitigation banking is part of this trend. Mitigation banking attempts to replicate valued functions resulting from wetland impacts by anthropogenically restoring and creating those functions.

---

[67] Hettenbach, Todd .1997. Brown University, Center for Environmental Studies, Thesis: "Market Based Approach to Wetland Regulation".

[68] The characteristic levelness of wetlands is a wetland attribute, however, this is not a currently valued as a wetland function.

[69]Some would argue that section 404 of the CWA never sought to protect wetlands but only wetland functions.

This presently is not the case in Rhode Island. Wetlands have the legal right to exist in the state. This protection is analogous to the protection that listed members of endangered species enjoy. The establishment of a mitigation banking system in Rhode Island would end the legal rights of the individual wetland, protecting only those wetland functions currently valued by society.

Wetland Functions

Mitigation banking is generally concerned with wetland functions, not attributes. Thus, wetland functions are divided into three broad categories: physical, chemical and biological.

Hydrological Functions

The single most important attribute of wetlands is hydrology; all functions of wetlands stem directly from their hydrology. Functional benefits associated with wetland hydrology include flood storage, storm abatement and erosion control.

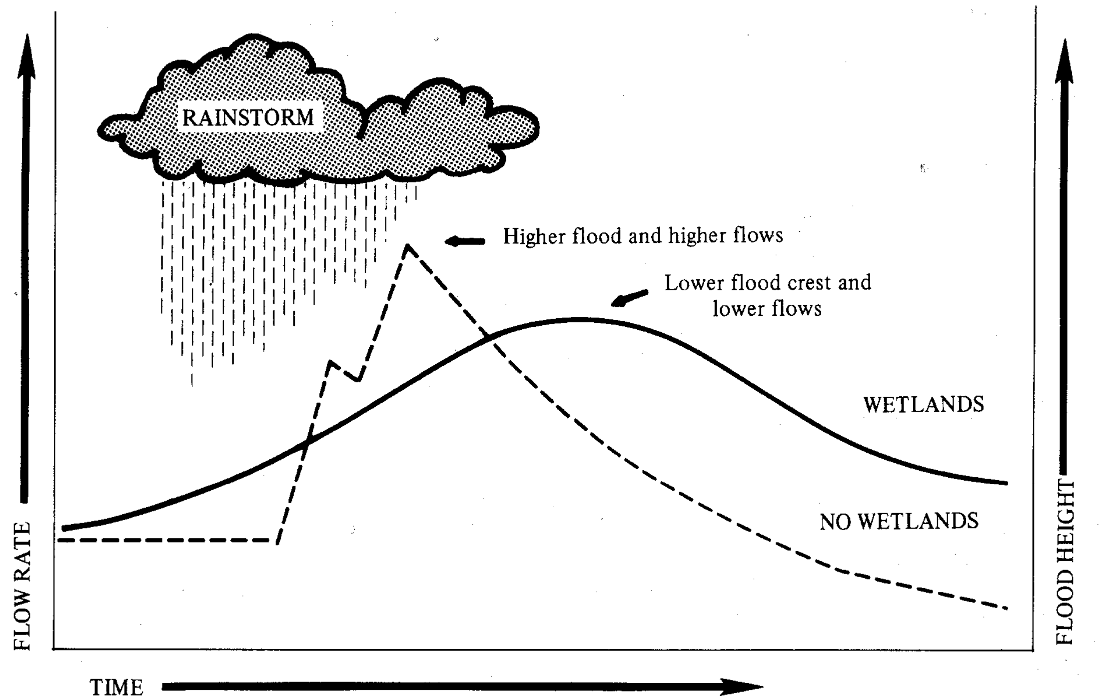
Flood Storage

Numerous studies have demonstrated the ability of wetlands to ameliorate the effects of flooding by storing stormwater runoff and reducing floodwater damages. The flood storage attributes of wetlands provide some of the most dramatic evidence of their function to society. Runoff is stored by wetlands and then gradually released to above or into groundwater bodies.[70] Figure 2.1[71] demonstrates the ability of wetlands to dampen the effect of the 'pulse' of runoff.

---

[70]Tiner, R.W. 1984.

[71] Ibid.



The flood storage capacity of wetlands is demonstrated by damage resulting from wetland losses. Reports on the 1973 and 1993 floods of the Mississippi River have concluded that these floods were the result of wetland destruction along the river.[72] One study argued that preserving one-half of the historic wetlands in the Upper Mississippi River Basin would have held back most of the flood waters that flowed past St. Louis in 1993.[73] Another study reported the Mississippi River storage capacity has decreased from 60 days of river flooding in presettlement time, to 12 days at present. This loss in

[72] Belt, C.S.1973. The 1973 Flood and Man's Constriction of the Mississippi River, 189 Science 681, Farrell, A.P.1995., Comment, Agricultural Non-Point Source Pollution and Wetlands: A Sensible Approach. 1 Mo.Environmental. Law and Policy Review.74. 74-75.

[73] Hey, D.L. and Philippi, N.S.. 1995. Flood reduction through wetland restoration: The Upper Mississippi River Basin as a case history. Restoration Ecology 3:4-17.

flood storage has been attributed to the destruction of hardwood wetlands around the river.[74]

In 1983, the Corps purchased 8,422 acres of wetlands along the Charles River in Massachusetts. It was estimated this would save $17 million[75] a year in averted flood damage to property.[76] The Corps predicted that a 40% reduction of the wetlands along the Charles River would result in 2 to 4 foot increases in flood peaks.[77]

No studies have estimated the value of wetlands in Rhode Island in ameliorating the damages of floods to properties. However, in the coastal flood zones in Rhode Island alone, there are an estimated $1.08 billion dollars of insured property.[78] In 1991, the relatively mild hurricane Bob caused $60 million worth of damage in Rhode Island.[79] Coastal wetlands dampen the severity of storm surges and inhibit erosion by binding soil with roots.[80] Wave energy and velocity is reduced through friction.[81] Rhode Island is at risk for flooding, severe storms and erosion. The state's wetlands serve the function of protecting development from the effects of these hydrological events.

---

[74] Gosselink, J.G., W.H. Conner, J.W. and R.E. Turner. 1981. Classification wetland resources; land, timber, and ecology. *In:* B.D. Jackson and J.L. Chambers (eds.) *Timber Harvesting in Wetlands.* Louisiana State Univ., Baton Rouge, L.A.

[75] In 1977 dollars

[76] Thibodeau, F.R. and D.B. Ostro. 1981. An Economic Analysis of Wetlands Protection. J. Environmental Manage. 12:19-30.

[77] Office of Technology Assessment , U.S. Congress, Wetlands, Their Use and Regulation 48-52 .1984.

[78] Virginia Lee.1996. Integrated Multi-Hazard Mitigation In Rhode Island. Coastal Resource Center, South Kingston, R.I.

[79] Rhode Island Emergency Management Agency.1994.

[80] Mitch and Grosselink.1993. Wetlands, 2nd ed. Van Nostrand Reinhold, New York.

[81] Metzer, K.J. and R.W. Tiner .1992. Wetlands of Connecticut U.S. Fish and Wildlife Service, Washington, D.C.

Water Quality

Wetlands are a primary mechanism for maintenance of water quality, providing natural treatment for many types of water pollution. The aquatic plants bacteria and fungi of wetlands remove organic and inorganic materials from water.[82] Wetlands also accumulate and trap sediments[83].

Rhode Island's water quality generally is good to excellent. However, water quality is a concern. Since 1979, contamination has forced the closure of 17 community wells[84] and 600 private wells by the Rhode Island Department of Health.[85] Non-points sources of pollution impact or threaten over 90% of Rhode Island's water. This is mainly attributed to the relatively densely developed landscape of the state.[86] There are three primary sources of anthropogenic pollutants affecting water quality in Rhode Island: fecal waste, nutrient loading resulting in excessive oxygen demand, and toxic chemicals.[87]

---

[82] Berry, J.F. and Dennison M.S. .1993.

[83] Klopatek, J.M.1978. Nutrient Dynamics of freshwater riverine marshes and the role of emergent macrophytes. *In*. R.E. Good, D.F. Whigmen, and R.L. Simpson (eds.) Freshwater Wetlands. Ecological Processes and Management Potential. Academic Press, New York.

[84]Nine of these wells were closed due to the presence of Volatile Organic Compounds (VOCs), typically trichloroethylene (TCE).

[85]RIDEM.1994. State of the State's Waters 305 (b) Report. Office of Environmental Coordination. Providence, RI.

[86]RIDEM.1988. Assessment of Non-point Sources of Pollution to RI Water. Office of Environmental Coordination. Providence, RI.

[87]RIDEM.1994. State of the State's Waters 305 (b) Report. And Comprehensive Conservation and Management Plan for Narragansett Bay. State Guide Plan Element 715, Report Number 71.(1991) Narragansett Bay Project

1. **Fecal Waste** is a primary source of waterborne bacteria and pathogens in the state's water.[88]
2. **Excess nutrients** like nitrogen and phosphates result largely from lawn and crop fertilizers, manure, and detergents. Nutrient loading is associated with eutrophication.
3. **Toxic chemicals** are released from both industrial and household sources.

Wetlands remove all three anthropogenic water pollutants.

The two pathogens of concern in the United States associated with fecal matter are viruses and bacteria.[89] Both natural and constructed wetlands reduce the indicator coliform bacteria.[90] In one study, it was determined that a wetland dominated by bullrushes reduced coliform bacteria from 90-99.7%.[91]

The ability of wetlands to serve as primary waste water treatment facilities is illustrated by the 150 cities and towns in the United States which are currently utilizing both natural and artificial wetlands for the treatment of sewage.[92] This includes the Solar-Aquatic Treatment Plant currently operating in Providence.

---

[88] Fecal waste is a major problem in the state, particularly in the Narragansett Bay watershed. The Narragansett Bay Project estimated that 90 billion gallons of treated wastewater enter the Bay from 32 Waste Water Treatment Facilities and an additional four billion gallons of untreated sewage and storm water enter the bay each year. The presence of fecal matter has led to the permanent closing of 28% of Narragansett Bay's shellfishing areas. Another primary non-point source of fecal matter is the state's 140,000 ISDS, 20-30% of which are estimated to be failing. Comprehensive Conservation and Management Plan for Narragansett Bay.

[89] Gersberg, Richard M., R,A.. Gearheart and Mike Ives.1989. "Pathogen Removal in Constructed Wetlands" in <u>Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural.</u> Donald Hammer., Ed. Lewis Publishers.

[90] Coliform bacteria live in the nutrient-rich environment of animal intestines. The presence of coliform bacteria in water indicates that that fecal matter has enter the water and pathogens are likely present.

[91] Spangler, F.W. Soley and C.W. Fetter.1976."Experimental Use of Emergent Vegetation for Biological Treatment f Municipal Wastewater in Wisconsin," in Biological Control of Water Pollution, J. Tourbier and R.W. Pierson, Jr.., Eds. University of Pennsylvania Press, pp. 161-171.

[92] Jewell, William J.1994. Resource-recovery and Wastewater Treatment. American Scientist, vol.82, 366-75.

Nutrients

Wetlands are effective in the removal of nutrients like nitrogen and phosphorus, both are listed by the EPA as water pollutants.[93] Of the nutrients affecting the waters of the state, nitrogen is considered the most serious threat to groundwater. Nitrogen moves freely within ground water because it is soluble. Fertilizers are one major source of nitrogen in the state. Approximately 2000 tons are used annually in the state, 80% for non-farm uses. ISDS are another primary source of nitrogen in Rhode Island. The DEM had reported that ISDS "almost inevitably cause(s) localized groundwater contamination" of nitrogen.[94]

When nutrients like nitrogen and phosphate are present in large amounts, blooms of phytoplankton occur. These phytoplankton are consumed by bacteria, which also consume oxygen. The increased oxygen demand by the decomposers may out strip the system's ability to provide it.[95] In extreme circumstances, the lack of oxygen may result in the killing of fish and other species valued by society.[96] This is called eutrophication.[97] It is sometimes called cultural eutrophication, because nutrient inputs

[93]EPA.1996. National Summary of Water Quality Conditions

[94]RIDEM.1994. State of the State's Waters 305 (b) Report. Section.-IV.C-58

[95]Called Biological Oxygen Demand (BOD): The BOD is an indirect measure of the biodegradable organic matter in an aqueous sample and this is a primary index of quality of waters. From Environmental Encyclopedia.1994. Eds. Cunningham W.P. and Terence Ball. Gale Research Inc.

[96]Corbitt, R.A. and Paul T.Bowen .1994. Constructed Wetlands for Wastewater Treatment. In. Applied Wetlands: Science and Technology. Ed. Donald M. Kent Lewis Publishers.

[97] Office of Technology Assessment , U.S. Congress, Wetlands, Their Use and Regulation 48-52 .1984.

are the result of anthropogenic sources. Wetlands are effective in the removal of nutrients like nitrogen and phosphorus, both are listed by the EPA as water pollutants.[98]

Nitrogen is retained by vegetation in wetlands and is then converted by bacteria into diatomic nitrogen gas and diffused into the atmosphere.[99] In a study conducted at the University of Michigan, a 1,700 acre peat bog removed more than 99% of nitrates and retained 95% of phosphates from 100,000 gallons of secondarily treated sewage in less than 24 hours.[100] The National Wildlife Federation reported that the loss of fifty percent of the remaining wetlands in the United States would cost some $75 billion dollars to replace lost sewage treatment functions for nitrogen.[101]

Phosphates are not diffused out of the wetlands systems, but are instead temporarily retained by vegetation.[102] Phosphate is stored for the long term by its deposition in both wetland soils and peat.[103] Studies of wetlands report a retention of phosphorus varying between 4% to 80%.[104]

Heavy Metals

---

[98]EPA.1996. National Summary of Water Quality Conditions

[99]Johnston, C.A.1991. Sediment and Nutrient Retention by Freshwater Wetlands: Effects on Surface Water Quality. Water Science Technology. 30(8): 235-244.

[100] Moyer, S. & Feierabend J.S.1991. National Wildlife Federation, Statement of National Wildlife Federation Before the Subcommittee on Environmental Protection and Federal Wetlands Legislation 13.

[101] National Wildlife Federation, Wetlands Are Vital to Protecting Our Nation's Water Quality .1993.

[102]Corbitt, R.A. and Paul T.Bowen .1994. Constructed Wetlands for Wastewater Treatment. In. Applied Wetlands: Science and Technology. Ed. Donald M. Kent Lewis Publishers.

[103]Hosomi, M.A.and R. Sudo. .1991. A Four-Year Mass Balance for a Natural Wetland System Receiving Domestic Wastewater. Water Science Technology. 30(8): 235-244.

[104]Johnson, Carol A.1991. Sediment and Nutrient Retention in Freshwater Wetlands: Effects on Surface Water Quality. Critical Reviews in Environmental Control. 21 (5,6): 491-565

Wetlands also have the ability to bind heavy metals, heavy metals are of concern for the surface water of the state. [105] Constructed wetlands are utilized by industry for their ability to filter heavy metals. Table 2.1 summarizes the ability of a constructed wetland designed for treatment of stormwater runoff from the 83,600 square meter Emerald Square Mall in North Attleborough, Massachusetts.

Table 2.1 Percentage of Metal Removed by Constructed Wetland at Emerald Square Mall, Massachusetts[106]

Metal	**% Removed**
cadmium	50-90%
chromium	50-90%

[105]Narragansett Bay and its tributary rivers receive significant discharges of heavy metals. Rhode Island's industries, present and historic, include electroplating and jewelry making, both of which are associated with heavy metals like copper, zinc, chromium, cadmium and lead. Comprehensive Conservation and Management Plan for Narragansett Bay.

[106]Daukas, P., Lowry, D. and William Walker. "Design of Constructed Wetlands for Treatment of Stormwater Runoff from a Regional Shopping Mall in Massachusetts" in Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Donald Hammer., Ed. Lewis Publishers.

copper	50-90%
lead	80-95%
mercury	50-90%
zinc	50-90%

Estimates of natural wetland ability to filter metals range from 20-100%.[107]

The 1994 State of the State's Water,[108] listed several concerns regarding water quality in the state:

> **Dwindling funding, uncertainty in further funding, strained state and local budgets, unregulated non-point pollution contributions, and lack of CSO funds hamper efforts to meet Clean Water Act requirements.[109]**

Wetlands are natural water purifiers, and also help deal with non-point pollution because of their diversity in the landscape. Further, wetlands remove or retain the three primary sources of anthropogenic water pollution,[110] making protection of our wetland resources a key to water quality.

Biological Functions

---

[107]Boto, K.G. and William H. Patrick, Jr.. Role of Wetlands in the removal of Suspended Sediment. in Wetland Functions and Values: The State of Understanding, Phillip E. Greeson, ed. Minneapolis: The American Water Resources Association .1978. Dellfino, J.J. and H.T. Odum.1993. Wetland Retention of Lead from a Hazardous Waste Site. Bulletin of Environmental Contaminant and Toxicology. 51(3):430. Gambrell, R.P. 1994. Trace and Toxic Metals in Wetlands: A Review. Journal of Environmental Quality. 23: 298-305.

[108]The 305(b) Report as mandated by the Federal Clean Water Act.

[109]Since the passage of the CWA, $296,000,000 have been spent on projects with significant water quality benefits in the stat. RIDEM.1994. State of the State's Waters 305 (b) Report.

[110]Ibid.

Wetlands are some of the most productive ecosystems in the world. Through photosynthesis, plants convert sunlight into biomass and produce oxygen.[111] See Figure 2.2 This is called Net Primary Productivity.[112] Through the surplus of biomass, wetlands are able to provide habitat for numerous species of plants and animals.

Wetlands have been referred to as biological "nurseries" because many species utilize wetlands for reproduction and development.[113] Nationally, wetlands are estimated to contain 190 species of amphibians, 270 species of birds and 5000 species of plants.[114] One Congressional reported described the biological functions performed by wetlands as:

> **The wetlands are the Nation's most biologically active areas. They represent a principal source of food supply. They are the spawning grounds for much of the fish and shellfish which populate the ocean, and they are passages for numerous upland game fish. They provide nesting areas for a myriad species of birds and wildlife.** [115]

Species Habitat

A high number of endangered species spend some part of their life cycle in wetlands. In 1991, the USFWS reported that of the 595 plant and animal species on

---

[111]Tiner, Ralph W, .1989.

[112]Net Primary Production is defined as the amount of energy left after subtracting the respiration of primary producers, or plants, from the total amount of energy. It is the total amount of "food" available from the process of photosynthesis- the amount of biomass available to feed organisms, that do not acquire food though photosynthesis. From Environmental Encyclopedia.1994. Eds. Cunningham W.P. and Terence Ball. Gale Research Inc.

[113] Berry, J.F. and Dennison M.S. .1993. Wetlands: Guide to Science, Law and Technology Noyes Publications. Park Ridge, New Jersey, U.S.A.

[114] Mitch and Gosselink .1993.

[115] S. Rep. No. 375, 101st Cong., 2d Sess. 2 .1990.

endangered species list, 256 (43%) were wetland dependent. Further, wetlands provided essential habitat for 60% of all threatened species.[116]

Wetlands have long been recognized as critical habitat for the nation's migratory waterfowl. They provide habitat for 100 million waterfowl in the United States, from the prairie potholes of North Dakota to the Northeast. Up to 50% of the nation's waterfowl spend some portion of their year in the pothole regions of North Dakota alone. Values placed on the wildlife functions of wetlands are demonstrated by dollars spent pursuing wetland dependent activities. In 1980, 55 million American's spent $10 billion dollars to watch and photograph water dependent species.[117] In the same year, 5.3 million Americans spent $638 million on goods associated with migratory bird hunting.[118]

Wetlands are also a critical habitat for fish populations, serving as marine nurseries.[119] Sixty to ninety percent of all US commercial fish caught ($10 billion) are dependent upon wetlands for some part of their life cycle.[120] In New England, two-thirds of the fish species require estuaries and salt marshes as nurseries or spawning grounds.[121] In the Southeastern part of the United States, 96% of commercial fish and shellfish are

---

[116] Feierabend, J.S. 1992. Endangered Species-Endangered Wetlands: Life on the Edge. National Wildlife Federation, Washington D.C.

[117] Ibid.

[118] U.S. Fish and Wildlife Service.1989. National Wetlands Priority Conservation Plan 22.

[119] Particularly coastal estuaries

[120] Feierabend, J.S. 1992. Endangered Species-Endangered Wetlands: Life on the Edge. National Wildlife Federation, Washington D.C.

[121] Neiring and Warren .1980. Vegitational Patterns and Processes in New England Salt Marshes.

dependent on estuarine and coastal wetlands.[122] The National Marine Fisheries Service valued the annual fisheries' loss due to estuarine wetland destruction at $201 million.[123]

In Rhode Island, the commercial fishing industry landed 120 million pounds of seafood in 1993, valued at $76 million dollars. The total economic impact of the commercial fishing industry in the same year was calculated at $254 million.[124] In 1989, it was estimated that 2.5 billion dollars in revenue was generated by the Narragansett Bay through direct exploitation of fisheries, tourism and marine related industries. Wetlands play a critical role in the support of the state's marine economy.[125]

Conclusion

Many of the functions and subsequent values which wetlands provide are public goods, meaning that an individual's benefit from a wetland's functions does not decrease the ability of others to benefit from the same function. However, public goods which wetlands provide are difficult to value. This leads to conversion to other uses. Public goods, like water quality, are only paid for once they are degraded. Further, individual owners of wetlands are not be compensated for the functions which wetlands on their property provide to society. At the same time, owners of wetlands must forgo the

---

[122] EPA. 1995. Wetlands Fact Sheet, Office of Wetlands. EPA843-F-95-001b.

[123] Strouded, Richard H .1992. National Coalition for Marine Conservation, Stemming the Tide of Coastal Fish Habitat Loss: Proceedings of a Symposium on Conservation of Coastal Fish Habitat.

[124] Office of Strategic Planning: Division of Planning, Department of Administration..1995. Rhode Island: Commercial Fisheries: Economic Adjustment Strategy.

[125] Recreational fishing also plays a significant part in the Rhode Island economy, with some 1.7 million recreational fishing trips made on Narragansett Bay in 1987. Desbonnet, A. and V. Lee .1991. Historical Trends, Water Quality and Fisheries, Narragansett Bay. The University of Rhode Island Coastal Resource Center. Contribution No.100 and National Sea Grant Publication #RIU-T-91-001, Graduate School of Oceanography, Narragansett, RI 101pp.

economic benefits associated with conversion to more market oriented uses.[126] The benefit of development to an owner can easily outweigh the benefits that the wetland gives to the owner if not developed.

Public goods associated with wetlands like flood storage and water quality improvements are generally undervalued in a market-based economy because benefits are not exclusionary. Since wetland functions are not valued in a market economy, individuals owning wetland cannot profit from the wetlands on their property. To maximize their benefits, owners of wetlands often convert wetlands to uses more tailored to valuation in the market economy like real-estate development. This has been called "inefficient habitat modification",[127] because the larger, but uncapturable, natural resource is converted to a smaller but capturable use.

State and federal laws designed to protect wetlands from conversion recognize the importance of the variety of functions and values which wetlands provide. Generally, federal and state courts have upheld the regulatory authority of the government to control wetland impacts upon private property. Courts have accepted wetland regulations as a valid expression of the government's power to protect against pollution and the public health interests.[128] The validity of the state's ability to curb development upon wetlands has most recently been upheld by the Rhode Island Supreme Court in January 1997 in the Case of *Alegria vs. Rhode Island Department of Environmental Management*. In this

---

[126] Scodari, P.F.1990. Wetlands Protection: The Role of Economics. Environmental Law Institute

[127] Costanza, R. , Farber, S.C. and J.Maxwell.1989. Ecological Economics, Vol. 1, pp. 335-361.

[128] See *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393 (1922)

case the Supreme Court upheld the DEM’s rejection of a permit to develop a parcel of wetland off Route 136 in Warren, as a valid expression of its authority.

The following chapter explains the context under which wetlands are regulated, and under which mitigation banking occurs.

Chapter Three Regulatory Context for Wetland Mitigation Banking

This chapter articulates the regulatory context under which mitigation banking occurs in the United States and describes the various operational mechanisms with which mitigation banks operate. Part one discusses the primary federal legislation regulating wetland resources, the Clean Water Act (CWA);[129] part two examines the evolution of mitigation requirements; part three explains some of the fundamentals of mitigation banking mechanisms and part four traces the spread of mitigation banking and state mitigation banking mechanisms. Finally, the nature of the evolution of compensatory mitigation is discussed.

Mitigation banking has evolved through a complex process. Much like the dynamic ecosystems it attempts to regulate, wetland legislation and regulation has developed organically. Legislative, regulatory and scientific uncertainties and the personalities of agencies have influenced the history of mitigation banking. All entities involved with mitigation banking, the agencies, the regulations and bank structures have undergone marked changes since wetlands were first federally protected.

The Clean Water Act

The purpose of the CWA is to "restore and maintain the chemical, physical and biological integrity of the nation's water".[130] Two primary programs have used to date.:

1. The National Pollution Discharge Elimination System: The National Pollution Discharge Elimination System regulates point source pollution from industrial and municipal systems.
2. Section 404: Section 404 regulates the discharge of dredge or fill material into the waters of the United States.

[129]The Clean Water Act of 1977, 33 U.S.C. Sections 1251-1376. originally the Federal Water Pollution Control Act of 1972.

[130]Ibid.

Agreements developed pursuant to Section 404 require applicants for wetland impacts to satisfy "mitigation sequencing"[131] and rules as a condition of permitting. Compensatory mitigation can take the form of creation of wetlands from uplands, the restoration of degraded or historic wetlands or functional enhancement of existing wetlands. Generally, federal wetland regulatory guideline express a preference for "on-site" mitigation, that mitigation occurs at or near the site of impact.[132] However, in the last decade, regulators have increasingly accepted "off-site" mitigation, and mitigation banking.

Activities which discharge dredged or fill material into United States waters are regulated under Section 404; activities that do not discharge dredge or filled materials but degrade wetland functions are not regulated under Section 404.[133] These activities include chemical discharges associated with impervious surfaces or nutrient loading from ISDS.[134]

Section 404 has evolved into the major federal regulation protecting the nation's wetlands. The Army Corps of Engineers is the agency charged with implementation of the 404 program, while the EPA has veto power over permit decisions.[135] This jurisdictional split resulted from the perceived need for balance: the Corps was viewed as

---

[131]Sequencing: Following the steps of avoidance of wetlands impacts, minimization if impacts and compensation of any impacts.

[132]Federal Guidance for the Establishment, Use and Operation of Mitigation Banks. Federal Register, Vol. 60, No. 228. 10/28/1995, here after the Guidance Document.

[133]Agricultural activities are also exempt

[134]other exemptions include discharges from farming operations like sediments and fertilizers.

[135]Section 404 (c) 33 U.S.C. 1444 (c). While the EPA has rarely vetoed Corps permits, no EPA 404 (c) vetoes have ever been overturned. See: *James City County v. EPA.* 12 F.3d 1330 (4th Cir.1993)

too developmentally oriented while the EPA was viewed as too environmentally minded. Further, until recently, the two agencies had an adversarial relationship that has contributed too much of the controversy surrounding wetland regulation. One commentator stated: “Section 404 is constructed on the backs of two beasts moving in different directions”.[136]

Regulatory History of Section 404

In 1972, Section 404 was enacted as part of the Water Pollution Control Act Amendments,[137] to regulate discharges associated with navigation ports and aquatic development. Originally, the Corps did not view Section 404 as a wetland protection statute; the agency confined its permitting authority to a narrow view of “navigable” as limited to the mean high-water mark. Since the passage of the Rivers and Harbors Act of 1890, the mean high-water mark had been the limit to the Corps regulatory authority.[138] As such, the Corps did not view the conversion of wetlands as being regulated or prohibited under Section 404.

The Corps was forced to expand its regulatory jurisdiction in 1973, after the court ruling in *Natural Resources Defense Council v. Calloway.*[139] Under 404, the Corps is now responsible for:

”waters such as intrastate lakes, rivers, streams

---

[136]Houck, Oliver A.1989. “Hard Choices: The Analysis of Alternatives Under Section 404 of the Clean Water Act and Similar Environmental Laws”. 60 U.Colo. L. Rev. 733, 774-775

[137]later to become the CWA

[138]Rivers and Harbors Act of 1890. ch.907, 26 stat. 426, 453-545 .1890. The Act sought to regulate the dredge and fill of navigable waters and promote navigation.

[139]392 F.Supp. 685 (D.D.C.1975)

> (including intermittent streams), mudflats, sandflats, wetlands. sloughs, prairie potholes, wet meadows, or natural ponds"[140]and "isolated wetlands"[141]

These responsibilities were added in the 1977 amendments to the CWA.[142]

Presently, the Corps' issuance of permits is regulated by the Section 404(b)(1) guidelines, promulgated by the EPA. [143] The guidelines are designed to avoid development on wetlands, primarily by mandating the examination of alternative sites. Any "practical" alternative to the filling of wetlands must be considered. This places the burden of proof on the applicant either to prove no "practical" alternative or that the project is water dependent.[144]

Types of Permits Under Section 404

There are two categories of permits authorized under Section 404, general and standard permits. Section 404 (e) authorizes the issuance of general permits for activities viewed to be of "similar in nature" and having "minimal individual and cumulative environmental impacts".[145] General permits make up over 80% of all permits issued by the Corps.[146] There are three types: Regional General Permits,[147]Programmatic General

---

[140]33 CFR 328.3(a)(3)

[141]328.3(a)(5)(7)

[142]33 U.S.C. 1362(7)

[143]33 U.S.C. 1344 (b)(1)

[144]That waterfront property is desirable for economic or aesthetic reasons is not a viable rationalization for wetlands impacts under 404(b) guidelines.

[145]U.S. Army Corps of Engineers.1995. Section 404 of the Clean water Act and Wetlands: Special Statistical Report U.S. Army Corps of Engineers Regulatory Branch. p.4

[146]Ibid.

[147]Limited to activities in a specific geographical region.

Permits[148] and Nationwide General Permits (NWP). [149] NWP are the most common general permits, there are some 40 different NWP. Examples of which are:

Nationwide Permits

- **Nationwide 13**. Bank Stabilization. Bank stabilization activities necessary for erosion prevention.
- **Nationwide 14**. Road Crossing. Fills for roads crossing water of the United States (including wetlands and other special aquatic sites).
- **Nationwide 20.** Oil Spill Cleanup
- **Nationwide 26.** Headwater and Isolated Waters Discharge. Discharge, dredge or fill material into headwater and isolated waters. Presently, the discharges of dredged or fill material that cause the loss or substantial adverse modification of one third to three acres of the waters of the United States requires predischarge notification. Activities that affect less than one third of an acre may proceed without notification. [150]
- **Nationwide 27.** Wetlands and Riparian Restoration And Creation Activities.
- **Nationwide 37.** Cleanup of Hazardous and Toxic Waste.

The most controversial of all Nationwide permits is NWP 26. NWP 26 authorizes activities that impact up to 3 acres of wetlands, and has been the most commonly issued of all the nationwide permits.[151] The Environmental Working Group (EWG) [152] estimated that of the 29,042 activities authorized in 1995 under the Nationwide permit program, 9,462 (35%) of these activities were authorized under NWP 26; EWG estimated that NWP 26 accounted for impacts to 7,432 acres out of 15,552 acres of a wetlands affected

---

[148]Based upon preexisting environmental protections at the state or local level.

[149]Nationwide permits: Federal Register/Vol. 56, No. 226/ Friday, November 22, 1991/ Rules and Regulation. Pp.59110- 59147

[150]Nationwide 26 is one of the most controversial of the NWP. In Rhode Island, there were only 10 Nationwide Permits issued between 1994 and 1995. However, in states with less strict wetlands regulations, NWP 26 would be a major impactor of wetlands.

[151]Until December of 1996, NWP 26 authorized the impact of up to ten acres of wetlands.

[152]Environmental Working Group.1996. Comments on the Proposed Reissuance of the U.S. Army Corps of Engineers' Nationwide Permits. http://www.ewg.org/pub/home/reports/nwp/nwp_impacts.html

by the Nationwide program in 1995.[153] A majority of these impacts were of less than one acre.

The Section 404 (b) (1) guidelines are not applied to NWP 26, but instead are governed by a separate set of regulations which states "discharge of dredged or fill material must be minimized or avoided to the extent practical at the project site, unless the District Engineer has approved a compensation mitigation plan for the specific activity".[154] The majority of the time mitigation is not required under NWP 26 permits.[155]

The Corps may not attempt to regulate impacts of less than one third of an acre simply for reasons of administrative necessity. In Fiscal Year 1994, the Corps processed over 48,000 Section 404 permits, 90% of which received a decision within 27 days[156]. In a state like Maine, which does not have wetland protection laws that are more stringent then the Section 404 standards, individuals may fill up to one-third of an acre of wetland with no notification to the federal or state authorities. Nationwide permits are currently not commonly issued in Rhode Island because of the state's strict protection of wetland impacts.

Standard Permits

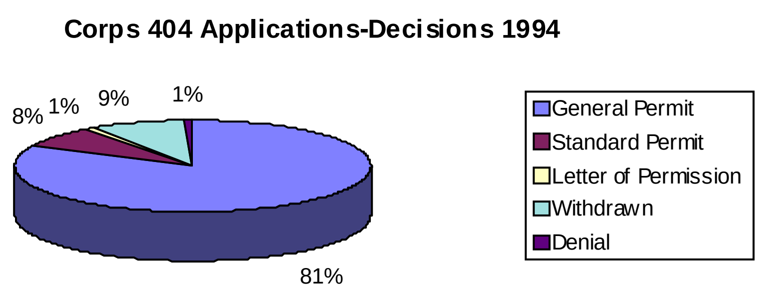
[153]This represents only those impacts which were reported, many Corps District Offices do not keep records of impacts.

[154]56 Fed.Reg. 59132; November 22, 1991.

[155]Wetland Mitigation Banking. IWR Report 94-WMB-6.

Standard permits are the basic authorization permits used by the Corps to evaluate individual, specific projects. The Corps considers these in three steps: pre-application (for major projects), formal project evaluation and decision making.[157] The formal project evaluation includes a public notice, a comment period and an evaluation of the project in compliance with the Section 404(b) (1) guidelines.[158] Considerations may include conservation, economics, aesthetics, cultural issues, navigation, wildlife habitat, water supply and water quality. Standard permits are required for about 10% of all projects with possible impacts to wetlands, 90% of these permits are granted[159]. Finally, the district engineer may issue a letter of permission if the proposed project is minor and viewed to have no significant environmental impact. Graph 3.1 summarizes the Corps permit decisions for 1994.

Figure 3.1[160]



---

[156]U.S. Army Corps of Engineers: Section 404 of the Clean water Act and Wetlands: Special Statistical Report July 1995. U.S. Army Corps of Engineers Regulatory Branch.

[157]Ibid.

[158]Established by the EPA to determine possible environmental impacts.

[159]Ibid.

[160] Section 404 of the Clean Water Act and Wetlands: Special Statistical Report. July 1995. U.S. Army Corps of Engineers; Regulatory Branch

Regulatory History of Federal Mitigation Requirements

Mitigation of environmental impacts is not a new concept under federal law; mitigation requirements for impacts upon aquatic resources have been required since at least 1934. The following section describes the major federal legislation and policies associated with the evolution of mitigation requirements.

Fish and Wildlife Coordination Act

The earliest federal statute that included mitigation requirements was the Fish and Wildlife Coordination Act of 1934.[161] The Act applies to federally permitted "water resource development projects," including Section 404 permits, requiring the FWS to consult with Corps in an effort to avoid and compensate for habitat losses.[162]

The National Environmental Policy Act (NEPA) [163]

NEPA, passed in 1969, established the first set of comprehensive environmental goals for the nation. NEPA requires any federal project significantly affecting the quality of the human environment to prepare an environmental impact statement. It also established the Council on Environmental Quality (CEQ) to advise the President. In 1978 the Council on Environmental Quality (CEQ) promulgated guidelines for all federal agencies, which articulated procedures to comply with NEPA. These guidelines included the following definition of mitigation:

---

[161] 16 U.S.C 661-667e (strengthened in 1946,1958 and 1965).

[162] It does not require the Corps to adopt any recommendations from the FWS.

[163] 42 U.S.C 4321-4335.

Mitigation:
A: Avoiding all impact altogether by not taking certain action or parts of an action.
B: Minimizing impacts by limiting the degree or magnitude of the action and its implementation
C: Rectifying the impact by repairing, rehabilitating, or restoring the effected environment.
D: Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
E: Compensating for the impact by replacing or providing resources or environments.[164]

This later became the mitigation definition adopted by the Army Corps and EPA, called sequencing.

Endangered Species Act of 1973 (ESA)

The ESA is designed to protect endangered species by prohibiting the "taking" of an endangered species.[165] Since an estimated 43%[166] of all endangered species spend some part of their life in wetlands, consideration of endangered species with regards to wetlands and mitigation is appropriate.[167]

In 1982, Congress authorized FWS to issue permits for an "incidental taking" of endangered species habitat if a "habitat conservation plan" (HCP) is prepared. These HCP's may include elements which "avoid and mitigate the take of a species." Mitigation has often taken the form of the creation of conservation areas as habitat for

---

[164]40 C.F.R. 1508.20

[165]Under *Babbit v. Sweet Home*, the Supreme Court expanded the definition of a taking to include the alteration or destruction of an endangered species habitat.

[166] Feierabend, J.S. 1992. Endangered Species-Endangered Wetlands: Life on the Edge. National Wildlife Federation, Washington D.C.

[167]Section 404 recognizes this, Nationwide general permit condition #11 reads in part "no activity is authorized under any NWP which is likely to jeopardize the continued existence of threatened or endangered species under the ESA."

endangered species. For example, near Palm Springs California, a 13,000-acre preserve on private lands was established as part of a HCP to mitigate the destruction by a residential development of the Coachella Valley Fringe-Toed Lizard's habitat.[168]

The 1990 MOA and Sequencing:

In 1990, an historically adversarial relationship was ended with the Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404 (b)(1) Guidelines (the MOA).[169]   In the MOA the Corps recognized the EPA's Section 404 (b)(1) guidelines, officially establishing sequencing as part of the 404 program. The MOA described "sequencing" as follows:

> The Corps....first makes a determination that potential impacts have been avoided to maximum extent practicable. Remaining unavoidable impacts will then be mitigated to the extent appropriate and practicable by requiring steps to minimize impacts and, finally, compensate for aquatic resource values."

This is essentially the definition of mitigation promulgated by the CEQ in 1978, only it is now called sequencing.[170]

The MOA did more than establish sequencing. It articulated as a national policy the "no overall net loss of wetlands".[171] This has been called the "closest the federal

---

[168]Rogers, J.W.1996. "Wetland Mitigation Banking and Watershed Planning". p. 296. In Mitigation Banking: Theory and Practice. Eds. Marsh,L.L. and Dougals Porter. Urban Land Institute.

[169]55 Fed. Reg. 9210 .1990.

[170]Readers should note that often mitigation and sequencing are used synonymously by government agencies.

[171]In order to achieve no net loss, the MOA established a preference for the functional replacement of "in-kind" replacement of permitted wetland losses. Functional values are to be assess by the utilization of assessment techniques. These techniques will be discussed latter in this chapter.

government has come to a national wetlands goal".[172] More importantly for this thesis, the MOA also opened the door for the development of wetland mitigation banks nationally by demonstrating unified positions upon sequencing and mitigation by two historically adversarial federal agencies: the Corps and EPA.

Federal Guidance Document

The trend towards official acceptance of mitigation banking was further confirmed in October of 1995 when the Corps, EPA, FWS, National Resources Conservation Service (NRCS), and the National Marine Fisheries Service (NMFS) issued the Federal Guidance for the Establishment, Use and Operation of Mitigation Banks. [173] The promulgation of these guidelines signified that Wetland Mitigation Banking is now an official policy of the federal government, and it made clear that mitigation banking is an acceptable means of satisfying the compensatory mitigation requirements under Section 404. The Guidance Document recognizes the possible regulatory benefits of mitigation banking:[174]

1. The consolidation of compensatory mitigation.
2. The consolidation of financial resources, planning resources and scientific expertise not available to most on-site mitigation projects.
3. Reduction of permit times.
4. Reduction of temporal losses of wetlands because mitigation banks function in advance.
5. Increased efficiency for limited agency resources to review and evaluate and monitor mitigation projects.

[172]Houck, Oliver A. and Michael Rolland.1996. "Federalism in Wetlands Regulations: A Consideration of Delegation of the Clean Water Act Section 404 and Related States Programs". Maryland Law Review. Vol.54. p.1257

[173] Guidance Document.

Most of these advantages are regulatory, and do not address the underlying scientific uncertainties of wetland replication.

The promulgation of the official guidance document will aid in the development of mitigation banks by removing many of the uncertainties that existed prior to its issuance. Further, elements of the guidance document are clearly designed to stimulate the development of Mitigation Banks. For example, the Guidance Document allows credits to be withdrawn from mitigation banks in advance of bank maturity.[175]

Structure of Mitigation Banking Systems

The legal mechanism for the operation of mitigation banks is called a “banking instrument”. A mitigation banking instrument’s purpose is to “describe in detail the physical and legal characteristics of the bank, and how the bank will be established and operated.” [176] The Guidance Document states fourteen types of information that a banking instrument must address:

1. Banks goals and objectives.
2. Ownership of banks lands.
3. Bank size and classes of wetlands.
4. Description of baseline conditions.
5. Geographic service area.
6. Wetland classes suitable for compensation.
7. Methods for determining credit and debits.
8. Accounting procedures.
9. Performance standards.
10. Reporting protocols and monitoring plan.
11. Contingency and remedial actions and responsibilities.
12. Financial Assurances.
13. Compensation ratios.
14. Provision for long-term management and maintenance.

---

[176]Ibid. p. 58609

Mitigation Credits

Mitigation banking requires currency, called mitigation credits. Mitigation credits are utilized both to determine the amount of compensation required for a wetland impact and for the valuation of credit production by the banker. This is one of the most controversial and complex issues in wetland mitigation banking, because "unlike dollar bills, one wetland is not equivalent to another".[177] There are four primary types of assessment methods that have been utilized by mitigation banks as credits: simple indices, narrowly tailored systems, broadly tailored systems and Best Professional Judgment.[178]

Simple indices attempt to capture the value of wetlands by measuring one indicator attribute of wetlands, the most common of which is acreage. It is assumed that in the case of acreage, that function will follow form. One acre of restored or created shrub-scrub swamp is assumed to serve the same ecological functions as the one acre of impacted shrub-scrub swamp. Most existing banks have utilized acreage as their mitigation credit.

Narrowly tailored assessment methods have been designed to assess specific wetland functions. The most common of these methods is called the Habitat Evaluation Procedure (HEP),[179] developed by the FWS. HEP evaluates an area and assigns it a numerical index values raging from 0 to 1.0, based upon the habitat it provide to a certain

---

[177]Wetland Mitigation Banking. IWR Report 94-WMB-6. p.63

[178]Ibid.

[179]U.S. Fish and Wildlife Service.1981. Ecological Services Manual, Standards for the Development of Habitat Suitability Index Models 103-ESM-1-2

indicator species. This numerical value is then multiplied by the relevant number of acres of wetland involved, and calculates a number of Habitat Units (HUs). HUs are used as credits.

Broadly tailored systems attempt to measure the multiple functions that a wetland provides. There are two primary assessment methods currently being utilized to consider multiple wetland functions: The Wetland Evaluation Technique (WET)[180] and the Hydrogeomorphic (HGM) approach.[181]. WET rates eleven different wetland functions and assigns a qualitative measure of their functions as low, moderate or high. These assess the probability that the wetland provides this function.

> Functions assessed by WET:
> Groundwater recharge, groundwater discharge, flood-flow alterations, sediment stabilization, sediment retention, nutrient removal, food chain support, aquatic diversity, wildlife diversity for breeding, wildlife diversity for migration and wintering and recreational opportunities.[182]

The most recent assessment technique is the HGM approach. The HGM contains a classification and assessment phase, based on hydrodynamics, water source, and geomorphic setting. The classification stage of HGM separates wetlands into five major types: riverine, slope, depressional, fringe, and flats. The assessment phase relies upon a

---

[180] Adamus, Paul R. Wetland Evaluation Technique (WET).

[181] Smith, R Daniel.1996. "An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification Reference Wetlands, and Functional Indices." Wetlands Research Program Technical Report WRP-DE-9. United States Army Corps of Engineers.

[182] Ibid.

set of regional reference wetlands from which an index of wetland functions is derived and calibrated in a scale if 0 to 1.0.[183]

Finally, many mitigation projects have relied upon Best Professional Judgment (BPJ). BPJ allows professionals familiar with wetlands to make decisions based upon their own knowledge. An analogy to commercial appraisals utilized by the insurance and banking industry has been made to this assessment technique.[184] However, BPJ is not standardizable.

Compensation Ratios

Compensation Ratios are the number of units of credit (whether HUs or acres) which must be debited from a mitigation bank to compensate for the units of wetland which are impacted. The majority of existing banks have ratios that fall between 1:1 and 2:1, generally using acreage as the mitigation credit. The Corps stated with regards to ratios and mitigation banking, "we can say there is already a net gain in wetlands, at least in terms of acreage. Whether this represents a net gain in functions is doubtful."[185]

The Corps reports three different reasons why compensation ratios are used:

1. To reflect the comparative value of out-of-kind replacements: For example, one wetland type may be viewed highly valuable in certain areas because of rarity.
2. Ratios to favor restoration over creation, recognizing restoration projects have a higher success rate than creation.
3. Ratios may reflect the knowledge that the replicated wetland may not replace all the functions of the impacted wetland.
4. Ratios maybe designed to insure the success of the bank site. A low ratio may be allowed for more mature banks viewed to be ecological stable and functioning while a younger bank site with less certain stability may receive higher ratios.

---

[183]HGM is still being developed by Corps.

[184]Wetland Mitigation Banking: First Phase Report. IWR Report 94-WMB-4. p.72

[185]Ibid. p.19

Compensation ratios reflect the uncertainties in wetland science and the uncertainty about out-of-kind replacements. Since compensation ratios are based upon these uncertainties, and uncertainties vary case by case, there is no set federal policy on compensation ratios. However, compensation ratios are always at least 1:1 to satisfy the "no net loss" requirements.

Types of Mitigation Banks

There are two primary types of mitigation banks which have evolved since the early nineteen eighties. The first type is the "single user" mitigation bank, a wetland bank constructed to satisfy the mitigation requirements of single, large, public or private entity like a state's Department of Transportation (DOT). DOTs utilize mitigation banking systems because of the multiple linear impacts to wetlands associated with road building. Single user mitigation banks represent most of the mitigation banks that are currently operating in the United States.[186]

The second kind of mitigation banks is entrepreneurial or commercial banks that offer mitigation credit to anyone in need of compensatory mitigation. Commercial mitigation banking has recently become more popular as regulations surrounding mitigation banking have become more formalized. Commercial banks are now being developed by private entrepreneurs, non-profit entities, or public agencies to create mitigation credit. These commercial mitigation credits are referred to by the Corps as *credit ventures*.[187]

---

[186]Commercial Wetland Mitigation Credit Ventures: 1995 suvery.1996. IWR Report 96-WMB-9. Institute for Water Resources. U.S. Army Corps of Engineers.

[187]Ibid.

The Spread of Mitigation Banking and State Mitigation Banking Requirements

The Fina La Terre Oil Company established the first authorized wetland mitigation bank in 1984 in Terrebonne Parish, Louisiana.[188] The bank was established to provide offsite mitigation for future impacts of oil and gas drilling operations. The bank is 7014 acres, designed to retard and reverse the conversion of a marsh into open water. The conversion is a result of a Corps construction project in 1904.[189] This bank is a single user mitigation bank designed only to compensate for the impacts of the Fina La Terre Oil Company.

By 1992, there were some 46 banks operating in 17 states. Forty-two of the 46 banks were single user banks,[190] predominately Department of Transportation banks. [191] Sixty more mitigation banks were in the planning stages. Prior to 1992, no entrepreneurial banks and only two publicly sponsored commercial banks were in operation.[192]As of the summer of 1995, 24 entrepreneurial banks were in operation with another 53 proposed or planned.[193] <u>See Appendix A: Map 3.1</u> The rapid spread of mitigation banking has resulted largely from the regulatory innovations that have occurred in recent years. The 1990 MOA and the issuance of the Federal Guidance

---

188Cathleen Short.1988. <u>Mitigation Banking</u>, Biological Report 88(41). U.S. Department of Interior.

189National Wetland Mitigation Banking: Resource Document. 1994. IWR Report 94-WMB-2. Institute for Water Resources.U.S. Army Corps of Engineers.

190Ibid.

19175% were DOT banks

192Commercial Wetland Mitigation Credit Ventures: 1995 suvery.1996. IWR Report 96-WMB-9. Institute for Water Resources.U.S. Army Corps of Engineers.

193Ibid.

Document has greatly bolstered the development of commercial credit ventures by removing regulatory uncertainties which has made commercial ventures tenuous.

State Statutes and Mitigation Requirements

Many states have mitigation requirements similar to the 404 requirements. Three primary regulatory mechanisms have been utilized for the establishment of mitigation banks on the state level. The first is to authorize wetland mitigation banks expressly through specific legislation; at least fourteen states have legislation explicitly addressing mitigation banking. See Table 3.1 For instance, the Maryland statute asserts the requirements of sequencing before mitigation may be acceptable. The statute includes a fee-based compensatory mechanism to The Maryland Nontidal Wetlands Compensation Fund that allows "monetary compensation paid by an applicant instead of engaging in the creation, restoration, or enhancement of a nontidal wetland".[194]

Fourteen states have relied on ad hoc agreements, generally in the form of Memorandums of Agreement (MOAs) or Memorandums of Understanding (MOUs) between the states' environmental regulatory agency and the wetland impactors. See Table 3.2 More than 50 existing banks utilize this instrument for formalizing the terms under which banks operate.[195] Finally, 13 states have allowed the establishment of DOT banks.[196] See Table 3.3

Table 3.1 States with Legislation Authorizing Wetland Mitigation Banking (as of Sept.96)

[194]Maryland Section 8-1209. Mitigation of losses: Nontidal Wetland Compensation Fund. It is unclear whether this would be an acceptable means of compensation under the Guidance Document.

[195] IWR Report 94-WMB-6.

[196]DOT's generally like to utilize mitigation banks because of the multiple linear impacts associated with road construction.

States	Legislation	Year Enacted
Arkansas	Arkansas Wetlands Mitigation Bank Act, 1995 Ark. Acts 562	1995
California	Sacramento-San Joaquim Valley Wetlands Mitigation Bank Act of 1993, Cal. Fish and Game Code Section 1775-1796	1993
Colorado	Resource Mitigation Banking Act, Colo. Rev. Stat. Section 37-85.5-101	1991
Florida	Florida Environmental Reorganization Act of 1993. Fla. Stat. Ann Section 373.4135	1993
Illinois	Interagency Wetland Policy Act of 1989. Ill. Ann. Stat. Ch. 20 paragraph 830/1-1 to 830/4-1	1989
Louisiana	Louisiana Coastal Wetlands Conservation and Restoration Act. La.Rev.Stat.Ann. Section 49:241.1 to 4.1	1995
Maine	Natural Resources Protection Act Wetland Protection Rules. Code Me.R Ch. 310, Section G	1990
Maryland	Non-tidal Wetlands Protection Act. Md. Code Ann.	1994
Minnesota	Minnesota Wetland Conservation Act of 1991	1991
New Jersey	Freshwater Wetlands Protection Act, NJ Stat Ann. Sections 13.9B-13	1995
North Dakota	Wetlands Bank Act, ND Stat Ann. Section 61-32-05	1987
Oregon	Oregon Wetlands Mitigation Bank Act of 1987	1987
Texas	Texas.Sess.Law Serv. Chapter. 3	1991
Wyoming	Wyoming Wetlands Act, Wyo. Stat. Section 35-11-308 to -311	1994

Table 3.2 States with Ad Hoc Agreements: Department MOA's (as of Sept.96)

Table 3.3 States with Transportation Banks

(as of Sept.96)

Alaska			**Alabama**
Arizona			**Mississippi**
Connecticut			**Montana**
Delaware			**Missouri**
Georgia			**South Carolina**
Hawaii			**Washington**
Massachusetts			**Wisconsin**
New York			**Idaho**
New Mexico			**Nebraska**
Michigan			**New Hampshire**
Ohio			**Nevada**
Pennsylvania			**North Carolina**
Tennessee			**South Dakota**
Utah			**Virginia**

The majorities of states either have cleared the way for the establishment of or have established some kind of mitigation banking system. Presently only seven states have no plan for any kind of wetland mitigation banking: Iowa, Indiana, Kansas, Oklahoma, Vermont, West Virginia, and **Rhode Island.** Map 3.2, Appendix A shows the regulatory status of mitigation banking as of the summer of 1992, and Map 3.3 Appendix A, shows the regulatory status as of the summer of 1996.

As is evident from Map 3.3, Appendix A, there are currently no commercial mitigation banks operating or planned in New England. However, other forms of mitigation banking are currently being practiced in New England, in all but two states. In New England, only Vermont and Rhode Island have no current plans for the establishment of Mitigation Banks. The rapid spread of mitigation banking across the landscape suggests that it is only a matter of time before mitigation banking is considered in Rhode Island.

Conclusion

The classic paradigm of public policy is, "science provides the means; the politicians and politics decide the ends."[197] However, the development of mitigation banking in the United States followed a different model. Compensatory mitigation requirements have evolved from the complex interaction of legislative mandates, governmental agencies responses to these mandates, the court system's reaction to both and finally, the evolution of the scientific understanding of wetland ecosystems and their replication. The evolution of mitigation banking has more closely followed a model of trans-science; Alvin Weinberg described trans-scientific questions as:

> ...questions of fact that can be stated in the language of science, that are unanswerable by science; they transcend science. In so far as the public policy involves trans-science rather than scientific issues, the role of the scientist in contributing to the promulgation of such policy must be different from his role when issues are unambiguously answered by science.[198]

As this chapter demonstrates, the policies governing compensatory mitigation requirements have not been made in the classic paradigm. Science did not provide the means for the compensatory requirements included in the CWA, analogous state requirement and the promulgation of the federal "no net loss" policy. Instead, politicians mandated both the means and the ends. The scientific community has struggled after the fact to provide the means with which to replicate wetlands. [199] Wetland regulatory development has been an organic process, because the associated agencies, legislation and science have grown in reaction to the regulations.

---

[197]Weinberg, Alvin A.1972. Science and Transcience. 10 Minerra 209. p.210

[198]Ibid.

[199]The following chapter will deal in depth with the Guidance Document, and demonstrate the trans-scientific nature of mitigation banking and its relationship to wetland replication.

Chapter Four:
The Technical Feasibility of Wetland Mitigation Banking in Rhode Island

The first step in considering whether a mitigation banking system should be established in Rhode Island is an assessment of the scientific and technical feasibility of wetland replication. Until recently, most mitigation projects failed to establish what kind of functions and wetland types the compensatory replicated wetland sought to replace; this absence of goal setting has made wetland mitigation hard to assess.

This chapter will demonstrate that the establishment of a mitigation banking system in the State of Rhode Island, based upon the Federal Guidance for the Establishment, Use and Operation of Mitigation Banks,[200] would not be technically feasible. The majority of wetland functions that are currently valued by society are not presently replicable. Further, there is evidence that the wetland types that are the vast majority in Rhode Island have the lowest success rate for replication.

Promulgated in November of 1995, the Guidance Document signified wetland mitigation banking as an acceptable means of satisfying the mitigation requirements established by the EPA under Section 404 (b)(1); the Guidance Document is used for two primary reasons. First, the federal government has joint regulatory authority over the wetlands of Rhode Island and second, the Guidance Document offers a template in which technical and regulatory issues surrounding mitigation banking can be explored.

Three elements of the Guidance Document demonstrate that a mitigation banking system in Rhode Island that sought to comply with this Federal template would be problematic.

1. **Replacement of Lost Functions:** Mitigation banks should replace the biological, chemical and physical functions of lost wetlands.
2. **In-Kind Replacement:** Replicated or restored wetlands should be of the same type as lost wetlands.
3. **Service Area:** Mitigation Bank should be in the same watershed as the lost wetland.

[200] Federal Guidance for the Establishment, Use and Operation of Mitigation Banks. Federal Register, Vol. 60, No. 228. 10/28/1995, here after the Guidance Document.

Replacement of Lost Functions

Guidance Document states:

> **the objective of a mitigation bank is to provide for the replacement of the chemical, physical and biological functions of wetlands which are the result of authorized impacts.**[201]

Despite mitigation banking's increasing popularity as a means of satisfying compensatory mitigation requirements, there is little scientific information to support the feasibility of mitigation banking to replace lost wetland functions. Compensatory replication of wetlands has a dismal record, plagued with both regulatory and technical problems. While humans in New England have been inadvertently creating wetlands since colonial times[202] through the building of millponds and roads, there is no evidence that humans can intentionally replicate functions.[203] Wetlands result from ecological processes that may take thousands of years to occur, yet the Guidance Document specifies only a five year monitoring requirement. While we can flood land and replicate certain elements of wetlands, creation of wetlands that serve the same functions as naturally occurring wetlands is difficult.

Even though mitigation banks have been in existence since 1984,[204] no peer-reviewed articles have been published assessing the success rates of wetland mitigation banks. The assessment of the science and technology of wetland replication therefore

---

[201] Guidance Document. p. 58607

[202] Golet, Francis C. and James Parkhurst.1981.

[203] Zedler, J.B.1996. Ecological Issues in Wetlands Mitigation: An Introduction to the Forum. Ecological Applications, 6(1). pp.33-37

[204] Fina La Terre Bank, Louisiana

must rely on studies of compensatory on-site mitigation attempts to replicate naturally occurring wetlands.

The most comprehensive review of the science and technology of wetland restoration and creation was undertaken by Kusler and Kentula (1990).[205] This work identified 3 major scientific reasons for the failure of constructed wetlands.

1. **Uncertainty** about the ecological functioning of wetlands
2. **Lack of baseline studies** of natural wetlands which projects seek to replace.
3. **Hydrological engineering difficulties** in restoring or recreating hydrology and soil types of replicated wetlands.

These points illustrate that fundamental questions regarding wetlands have yet to be answered. If science lacks basic information on the functioning of naturally occurring wetlands, then how can anthropogenic wetlands seek to replicate their functions?

Those studies that have assessed replicated wetlands report failure rates around 50%; Table 4.1 summarizes data on four studies assessing the success of compensatory mitigation projects. These studies defined success as meeting three criteria:

1. **Site Started:** whether the compensatory site was created.
2. **Wetland Plants:** the presence of wetland plants on the site (generally percent coverage of site).
3. **Acreage Requirements:** the sites met acreage requirements established by the permit.

---

[205]Kulser, J A. and Mary Kentula. eds.1990. Wetland Creation and Restoration: the statues of the science, Island Press, Washington D.C.

The fact that many replication sites were never begun makes it difficult to assess. This regulatory failure has hampered efforts to evaluate wetland replication technology. However, no studies have had a success rate of over 60% even when replication sites were begun.

Further, these studies did not seek to ascertain whether the replicated wetland had replaced lost wetland functions. For example, in the Massachusetts study, success was defined as coverage of at least 75% indigenous wetland vegetation and equal acreage to lost wetlands. To quote:

> **This study was not designed to address questions concerning the "functional" value of replacement wetlands versus those of filled wetlands. Virtually all the successful replacement wetlands, however, were marshes or wet meadows dominated by herbaceous species. These wetlands may have substantially different functional values to filled wetlands, most of which were forested or scrub-shrub wetlands.[206]**

Even when judged by the relatively low threshold condition of being started, having wetland plants and equal acreage to lost wetland plants, there is no evidence in the literature to suggest that on-site mitigation requirements which pre-date mitigation banking have been successful. It is generally assumed that on-site mitigation will be more successful than off-site, because of the on-site hydrology is generally conducive to wetland replication.

Proponents of mitigation banking claim that a mitigation banking system would improve success rates by bringing together financial and technical resources, while making regulatory assessment of compliance easier through the consolidation of compensatory mitigation.

---

[206]Ibid. p.ii.

Table 4.1 Summery of Studies Assessing Success Rates for Compensatory Wetland Mitigation

Study Area	Authors	Criteria for Success	# of Sites	Success Rates
San Francisco Bay Area	Elliot, W. 1985[207]	• whether restoration was begun	58	• 56% compliance • 44% never started

[207] Elliot, W.1985. Implementing mitigation policies in San Francisco Bay: A critique. California State Coastal Conservancy. 46 pp.

Norfolk, Virginia	Maguire, C.E. 1985[208]	• ability to locate • wetlands plants growing • general permit condition met	26	• 50% compliance • 23% partial success • 27% never started
Florida	Florida Department of Environmental Protection (1990)[209]	• Ecological success defined as "functioning or tending towards function as, a wetland of the intended type". • Primary measure was vegetative characteristics of site	119	• 34% never begun • 81% non-compliance with permit • 27% functional success[210]
Massachusetts	US Army Corps (1989)[211]	• 75% coverage of indigenous wetland vegetation • equal acreage of lost wetlands	94	• 57% success rate • 36% unsuccessful

Very few studies have been conducted to assess whether it is scientifically possible to replicate the "chemical, physical and biological functions" of lost wetlands. Certain wetland functions, like flood storage, appear to be replicable.[212] There is also a long history of the USFWS building marshes as habitat for waterfowl, mostly through the impoundment of streams.[213] However, a duck pond with flood storage capacity does not

---

[208]Maguire, C.E.1985. Wetland Replacement Evaluation. U.S. Army Corps of Engineers, Norfolk District. Contract No. DACW-65-85-D-0068. Norfolk, V.A. 188 pp.

[209]Redmond, A.M.1995. Florida Moves to Mitigation Baking. National Wetlands Newsletter. Nov-Dec. 14-19.

[210]Freshwater: 12% ecological success. Saltwater: 45% success.

[211]US Army Corps of Engineers: New England Division. 1989. Evaluation of Freshwater Wetland Replacement Projects in Massachusetts

[212]Kusler, 1990.

[213]Ibid.

provide the same range of functions as a naturally occurring pond or the wetland lost in creating the pond.

While the Guidance Document requires that all lost functions be mitigated, studies demonstrate that this is scientifically unlikely at this time. One workshop addressing the replication of freshwater wetlands in the Glaciated Northeast in 1986[214] sought to assess the scientific bases behind mitigation requirements. While the workshop concluded that the flood storage functions of wetlands could be replicated, it further stated:

> **the scientific base knowledge is too incomplete to support assertions that artificial wetlands will provide the other functions of natural wetlands, especially those associated with water supply, water quality and nutrient transformation.[215]**

A forum held in the summer of 1996 by the Ecological Society of America;[216] found that the science of wetland replication has not substantially improved in a decade. This Forum stated:

> **The presumption that a site can be modified to replace a specific ecosystem, or to perform in predictable ways, is at odds with current ecological understanding of ecosystem complexity.[217]**

---

[214]Larson J.S. and Christopher Neill, eds. 1986. Mitigating Freshwater Wetland Alterations in the Glaciated Northeastern United States: An Assessment of the Scientific Base. The Environmental Institute: University of Massachusetts at Amherst.

[215]Ibid. p.15

[216]Zedler, J.B.1996.

[217]Ibid. p.33

There is no evidence in the literature to suggest that it is scientifically or technically feasible for mitigation banking to achieve the goal of functional replacement, as stipulated by the Guidance Document. Thus, mitigation banking system could not be established in Rhode Island to achieve this goal of functional replacement. To quote Frank Golet:

> **Wetlands simply cannot be moved around the landscape like so many chessmen, without seriously disrupting their natural functioning and degrading their values.**[218]

In-Kind Compensation:

Another limiting factor of the Guidance Document is the expressed preference for in-kind compensation. In-kind compensation requires permitted wetlands impacts are compensated by the replication of the same wetland type. While this may seem to be the same as functional replacement, it is not. Wetlands of different types can serve the same functions, like flood storage or migratory bird habitat.

The Guidance Document states: “in the interests of achieving functional replacement, in-kind compensation of aquatic resource impact should generally be required”.[219] This is included because performance of some functions is difficult to evaluate and it is simpler to categorize wetland types.

The following section evaluates the success rates of replication for different types of wetlands, and compares these success rates with the prevalence of wetland types in Rhode Island. Once again, because of the general lack of research there is considerable

---

[218]Golet, F.C.1986. Critical Issues in Wetland Mitigation: A Scientific Perspective. National Wetlands Newsletter 9-10. p.6.

[219]Guidance Document. p.58611.

uncertainty in the specific success rates for replication of different wetland types. However, this does not affect the conclusion that the vast majority of wetlands in Rhode Island are very difficult to replicate on a reasonable time scale.

Success rates for replicated wetlands vary significantly between wetland types. The literature suggests five basic criteria influencing the ability to replace wetlands.

1. **Replication of hydrology is the most essential element in mitigation design.**
2. **Those wetlands dependent upon surface water have higher success rates than those wetlands supplied by ground water.**
3. **Tidal wetlands have much higher success rates than non-tidal because of the predictability of their hydrology and elevation.**
4. **Wetland types with fast-growing or seasonal vegetation have been more successful than those dominated by longer growing species.**
5. **The relative diversity of plant species influences the success of replicated wetlands, with those with low diversity being more easily replicable then those with high diversity.**

The highest success rates for replicated wetlands have been with estuarine marshes. Estuarine marshes meet the five criteria for success.[220] Also, these wetlands have been actively managed since colonial times[221] and extensively studied.[222] Hydrologically, estuarine marshes are supplied by tidal surface water, which is easily predicted and engineered. The vegetation of estuarine marshes can be established in a few seasons, and there is a relatively low diversity of plant species.

---

[220]White, T.A., Blaire, C.L. and Keith B. MacDonald. 1992. "Wetland Replacement: The Art and Science of Renewing Damaged Ecosystems". Renewable Resources Journal. Kusler, J.A. and Mary E. Kentula. 1990.
[221]Shisher, J.K.1990. "Creation and Restoration of Coastal Wetlands of the Northeastern United States". In Wetland Creation and Restoration the Status of the Science. Eds. Kusler, J.A. and Mary E. Kentula. Island Press.

[222]Beeftink, W.G. 1977. Salt Marshes, p 93-121. In R.S.K. Barnes (Eds.) The Coastline. John Wiley & Sons, London.

Moving inland to other wetland types, the five criteria explain the decreasing success as the hydrology of the wetlands types move from tidal to surface water to ground water. Also, the diversity of plant species in wetlands increases when moving inland. Table 4.2 summarizes the success rates of wetland types and compares those rates to the percentage of these wetland types in Rhode Island. Notice that 87% of the wetlands in Rhode Island are listed as having low success rates. This, in the context of a general mitigation failure rate of 50%, demonstrates that a vast majority of the time it will be impossible to recreate lost wetlands in the state. Thus, it will be impossible to meet the Guidance Document's mandate of in-kind replacement of wetlands in Rhode Island almost 90% of the time.

Table 4.2 Summary of Success of Wetland Replication Compared with Prevalence of Type in Rhode Island[223]

Type of wetland	Success of Replication	Hydrology	Diversity of Plant Species	Other Influencing Factors	Prevalence of Wetland Type In RI by %
Estuarine marshes[224]	**highest**	**tidal**	**low**	**plant species easily established quick time frame 2-3 years longest experience and largest literature base**	**4%**

[223]Kusler, J.A. and Mary E. Kentula . 1990. Kusler, J.A. Issues in Wetland Protection, National Wetlands Policy Forum The Conservation Foundation, .1990., Larson, J.S. and C. Neil. .1986. Mitigating Freshwater Wetland Alterations in the Glaciated Northeastern United States: an assessment of the science base Proceedings of a workshop held at University of Massachusetts, Amherst.

[224] Estuarine wetlands dominated by salt grasses like Spartina patens have been almost impossible to replicate, probably due to salinity tolerances.

Coastal Marshes	**high**	**tidal**	**low**	**same as estuarine**	**3%**
Freshwater marshes along lakes, rivers, streams	**moderate**	**surface water**	**moderate**	**problems with exotic/invasive species like cattails and phragmites**	**4%**
Isolated marshes supplied by surface water	**low**	**surface water**	**moderate**	**limited experience and literature except for waterfowl impoundments**	**10%**
Forested wetlands	**low**	**ground water**	**high**	**narrow range of hydrologic tolerance many years to establish**	**75%**
Isolated freshwater wetlands: marshes, bogs, fens	**lowest**	**ground water**	**high**	**elevations are critical many years to establish**	**2%**

Service Area: Watersheds.

The final limiting factor the Guidance Document presents is the service areas of mitigation banks. The Guidance Document states that a "goal of mitigation banking is to compensate for damages done to the long-term ecological functioning of the watershed within which the bank is located".[225] This establishes a preference for the mitigation bank to occur within the same watershed as the permitted wetland loss.[226] This section will demonstrate the logistical difficulty by classifying the wetlands by type in one of the twelve major watersheds in Rhode Island.

[225]Guidance Document, p. 58608.

[226]Watershed: The land area that delivers the water, sediment, and dissolved substances via small streams to a major stream or river.. From Miller, G.T.1997. Environmental Science., 6th ed. Wadsworth Publishing Company.

Watershed management has recently become a popular means of protecting and restoring aquatic ecosystems.[227] Supporters of mitigation banking promote wetland replication as an "integral part of watershed plans, facilitating ecological restoration and economic development".[228] The Guidance Document seeks to use watersheds as a ecological unit for planning and managing wetland mitigation. Perhaps this is in response to one of the major criticisms of the 404 program. Section 404 (b)(1) guidelines have been criticized for allowing large numbers of individual discrete permit decisions which did not consider the cumulative effects of permitted wetland losses.[229]

In Rhode Island there are 12 major watersheds,[230] which would represent 12 different wetland mitigation bank service areas.[231] From these service areas, compensatory mitigation credits could be withdrawn. See Map 4.1 Major Watersheds of Rhode Island, Appendix A. To illustrate the difficulty that would be encountered when attempting to base a mitigation banking service area on a watershed, the largest watershed in Rhode Island, the Pawcatuck Watershed, will illustrate the point.

The Pawcatuck Watershed contains a total of 194,000 acres,[232] 137,729[233] of which are in Rhode Island. Seven major rivers and their tributaries are drained by the

---

[227]Adler, R.W.1992. Addressing Barriers to Watershed Protection. 25 Envtl. Law. 973. Northwestern School of Law of Lewis and Clark.

[228]Rogers, J.W.1996. Wetland Mitigation Banking and Watershed Planning. In. Mitigation Banking: theory and Practice. Eds. Marsh,L.L. and Dougals Porter. Urban Land Institute.

[229]Adler, R.W.1992.

[230]RIGIS

[231]For tidal wetlands, the appropriate service area would be coastal drainage basins.

[232]The Pawcatuck Watershed Partnership.

[233]RIGIS

watershed, the Wood River and Pawcatuck River being the major rivers in Rhode Island.[234] The Pawcatuck is a good watershed to demonstrate the difficulty in implementing the Federal Guidance Document because it is under increasing land use pressures associated with population and economic growth.[235] As a result wetlands in this area will be under increasing pressure.

A watershed based service area would encounter the problems of replacement of lost function and in-kind replacement, but on a smaller geographic scale. In the Rhode Island part of the Pawcatuck Watershed there are 21,782 acres of wetlands. Breaking down these wetlands by type illustrates the difficulties a mitigation banking system would encounter.

Table 4.2 Pawcatuck Watershed Type by Acre

Wetland Type in Watershed	Number of Acres	Percent of Total Wetlands	Success in Restoration/Creation
Estuarine	89	0%	highest
Marine	38	0%	high
Emergent	510	2%	moderate
Scrub-shrub	6606	30%	low
Forested	14,538	68%	low

Evident from Table 4.2 is that 98% of the wetlands in the Pawcatuck Watershed would have difficulty meeting the Guidance Documents requirements.

Conclusion

Rhode Island has the opportunity to assess whether a mitigation banking system would be a viable tool for wetland management, and the recently promulgated Guidance Document could serve as one vehicle for assessment. Most states with mitigation

[234] Major rivers in watershed: the Chipuxet, Chickasheen, Wood, Queen, Pawcatuck Rivers in RI, the Shunuck and Green Fall Rivers in Connecticut.

[235] For example: Foxwoods Resort and Casino is in the Pawcatuck Watershed.

banking systems have not had the foresight or luxury of such an assessment. It is only now that a mitigation banking system is in place that other states are assessing the viability of wetland replication.

Obviously, a mitigation banking system that sought to be in compliance with the Federal Guidance Document would not be feasible in the State of Rhode Island. The science and technology of replication cannot, at this point, achieve the mandated goals of replacement of lost function, of in-kind replacement in the context of watershed service areas.

The next chapter will discuss possible ways in which a mitigation banking system in Rhode Island could serve as a useful tool for wetlands management, recognizing the limitations presented in this chapter. The Guidance Document's recognition of importance of watersheds in the context of wetland management is utilized to address wetland functional needs.

Chapter Five: Using Wetland Mitigation Banking in Rhode Island to Address Wetland Functions

Currently, functional and in-kind replication of the wetlands of the state is not a viable goal; any mitigation banking system in the state must acknowledge the technical and scientific limitations of wetland replication. Recognizing these limitations, this chapter examines possible off-site mitigation mechanisms. Off-site mitigation could be integrated into long range watershed based wetland preservation and restoration efforts by addressing the functional needs of specific watersheds. This chapter presents a basic structure for considering off-site mitigation in a watershed context and discusses how mitigation banking could be used as a means of extending wetland protection to the protection of wetland functional quality.

Five basic recommendations could serve as a rudimentary framework for considering a mitigation banking system in the state.

1. Mitigation banking should not compromise sequencing.
2. A mitigation system must recognize the limitations of wetland replication science

and give preference to projects with a high likelihood of success.

3. Mitigation should be considered in the context of watershed planning, assessing the needs and goals of watersheds in terms of wetland functions. The goals of specific watersheds could be integrated with mitigation banking by identifying potential restoration sites that would provide desired wetland functions.
4. Wetland replication serving as compensatory mitigation should represent a net gain in socially valued wetland functions. This places higher value on existing wetlands and functions provided. It also recognizes the inherent uncertainties of ecosystem management.
5. Consideration should be given in the future to require compensatory mitigation for projects that do not directly result in the fill of wetlands but do degrade wetland functions.

The Need for Functional Protection

Since all wetlands in Rhode Island are currently protected from unpermitted conversions, the primary pressures on the state's wetlands are impacts upon their functions. Anthropogenic land use patterns have impacted wetlands in many of the state's watersheds to the degree that desired wetland functions have been greatly reduced. Many watersheds lack the desired level of wetland functions like flood storage or wildlife habitat.

The functional pressures upon Rhode Island's wetlands generally result from land use patterns. The movement of the population from urban areas to suburban and exurban areas is fragmenting and degrading wetland functions. Associated road building and increases in impervious surfaces have resulted in the fragmentation, isolation and alterations in hydrology of wetland at the watersheds level. Further functional pressures stem from chemical inputs associated with ISDS.

Currently, regulatory agencies can do little to address the functional degradation of wetlands. The regulatory system only addresses wetland degradation site-by-site and permit-by-permit. This does not address the pressures upon wetlands occurring on the landscape level through multiple, incremental insults. The result is the protection of an ever-decreasing functional status quo, only holding the line against future wetland losses but not addressing cumulative functional degradation of the state's wetlands. Mitigation banking could be a vehicle for extending compensatory mitigation to functional impacts not associated with filling. However, it is unclear whether there is presently the ability to assess cumulative low level impacts at this time.

Off-site versus on-site mitigation

Any compensatory wetland mitigation should be considered only after strict sequencing has been followed, insuring that wetland impacts are avoided and minimized. Rhode Island is in this position because it has not generally utilized on-site mitigation as a regulatory tool. So few wetlands are filled or directly impacted that mitigation has rarely been a consideration. Instead the state has relied upon the avoidance and minimization techniques. However, some on-site mitigations have occurred. These mitigation sites have been plagued with the same lack of goal setting as other mitigation efforts.

Three freshwater wetland replication areas were constructed in 1989, establishing approximately 6.7 acres of replicated wetlands.[236] These replication sites were on-site, "located in close proximity to the roadway and lie adjacent to surrounding undisturbed

[236]Woonsocket Industrial Highway/ Route 99 : Wetland Replication Monitoring.

wetland communities".[237] There was no clear goal setting in these projects, and required monitoring expired in 1991. Frank Golet asserts these sites have failed to compensate for lost wetland functions.[238]

Generally, the Corps and EPA have preferred on-site mitigation projects:[239]

> On-site mitigations are preferable where there is a practicable opportunity to compensate for local functions including local flood control functions, habitat for a species or populations with a very limited geographic range or narrow environmental requirements, or where local water quality concerns dominate.[240]

However, the Guidance Document also states:

> The agencies' preference for on-site mitigation...should not preclude the use of a mitigation bank when there is no practical opportunity for on-site compensation, or when use of a bank is environmentally preferable to on-site compensation.[241]

Thus on-site or off-site mitigations should be considered in terms of likelihood of success and compatibility with adjacent land uses.

What Wetland Types and Functions Should be Replicated?

A mitigation framework should recognize the limitations of wetland replication science, and attempt mitigation projects only with a high likelihood of success. Numerous studies have demonstrated that wetland restorations have a higher likelihood

[237]Ibid, p.1.

[238]Telephone interview with Prof. Golet 8/3/1996.

[239]Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404 (b)(1) Guidelines

[240]Guidance Document, p.58611.

[241]Ibid.

of success than wetlands created from upland areas.[242] Recognizing this, the Guidance Document states "restoration should be the first option".[243] As such, the restoration of degraded or historic wetlands should take precedent over creation projects.

Only those wetland types and functions that have been replicated with some success should be attempted. Table 4.1 suggests a hierarchy of preference for the restoration of former or severely degraded wetlands types and the functions with the highest likelihood of success; it demonstrates that the replication of flood storage and habitat restoration functions should be attempted before attempted replication of water quality and nutrient transformation functions.[244] Thus, an attempt at the restoration of a historic salt marsh which sought to provide flood storage and wildlife habitat should be considered before an attempt at creating a forested wetland to achieve water quality benefits.

Mitigation Banking Should Be Integrated With Watershed Management

Recently wetlands have begun to be considered in the context of watershed management.[245] As such, mitigation banking should also be considered in this context. There are two reasons.

1. The EPA increasingly utilizes watershed based programs. For instance The Federal Guidance Document encourages mitigation banking to "address the specific resource needs of a particular watershed".[246] Also, a mitigation banking

---

[242]Kulser, J A. and Mary Kentula. eds. 1990. Wetland Creation and Restoration: the Statues of the Science, Island Press, Washington D.C.

[243]Guidance Document,p.58608.

[244]Larson J.S. and Christopher Neill .1986.

[245]Adler, R.W.1992. Addressing Barriers to Watershed Protection. 25 Envtl. Law. 973. Northwestern School of Law of Lewis and Clark.

[246]Guidance Document, p.58609 part 6.

system must have a service area. Watershed service areas are an ecological unit for planning and managing wetland mitigation.
2. Watershed management addresses some of the limitations of current permitting systems.

Watershed Based Programs

The EPA has been promoting watershed planning frameworks since 1991. For example, the EPA and states are currently transitioning to a five-year watershed based monitoring and reporting cycle from the two-year cycle currently required under Section 305 (b) of the CWA.[247] Other initiatives presently underway in Rhode Island at the behest of the EPA include development of citizens groups like the Pawcatuck Watershed Partnership. Finally, there are several sources of funding available to states through the EPA to develop watershed protection plans.[248]

Several watershed based plans already exist in Rhode Island or are in the process of being developed. The Narragansett Bay Project was a major attempt at watershed based environmental management plan. [249]

Finally, Massachusetts is also using a watershed based approach towards wetland management and is currently developing plans for an experimental mitigation banking system which will use watersheds as service areas.[250] Since 69% of the 147 square miles of the Narragansett Bay Watershed are in Massachusetts, attempts should be made to

---

[247]305 (b) reports are mandated under the CWA to report on the state of the state's waters.

[248]These include grants CWA Section 104 (b) grants, Section 319 grants, and Section 604 (b) planning grants may be used to develop state watershed protection plans.

[249]Another Watershed plan: The Scituate Watershed Reservoir Watershed Management Plan. Rhode Island Division of Planning.1990. State Guide Plan Element 125.

[250]Wetlands Mitigation Banking In Massachusetts. Report and Recommendations of the Wetlands Restoration & Banking Advisory Committee to Massachusetts Secretary of Environmental Affairs Trudy Coxe. August 22,1995.

integrate the ecological boundaries of watersheds with political boundaries. Since both Rhode Island and Massachusetts have strong wetland protection laws, cooperation on watershed based wetland mitigation should be possible.

Limitations of Current System

The current regulatory system has anthropomorphized wetlands by treating them as discrete, individual entities. The permitting system recognizes only the impacts to individual wetlands, not recognizing the connection with the larger watershed context. However, wetlands are part of the complex hydrology of a watershed; wetlands are the surface expression of a watershed's hydrology.[251] Watershed management addresses this major shortcoming of the current regulatory system by broadening permitting decisions to the landscape level.[252]

Identification of Watershed Needs

A mitigation system not limited to exact functional and in-kind replacement could help to address the specific problems of each watershed. The Guidance Document states that "banks may be also be used to address other resource objectives that have been identified in a watershed management plan or other resource assessments."[253] If the needs of the watershed are evaluated in the state prior to the need for compensatory mitigation, those wetland functions that are most valued could be prioritized. The

---

[251] Adler, R.W.1992.

[252] Ibid.

[253] Guidance Document, p. 58608 part 1. This should not deter from the critique of the Guidance Document present in the previous chapter, because the Guidance Document presents an unattainable standard of functional and in-kind replacement first and foremost.

possible functional needs of some of Rhode Island's watersheds demonstrate how mitigation banking could be integrated into the context of watershed planning.

In the highly developed Blackstone and Pawtuxet watersheds, flooding is a serious problem. These watersheds have lost high numbers of wetlands and the corresponding flood storage functions. The Corps estimated in the Pawtuxet watershed, that the cities of Cranston and Warwick would suffer $3.6 million from the next twenty-year flood and 5.5 million dollars from the next fifty-year flood.[254] In these highly urbanized areas, the restoration of historic wetlands sites might be appropriate to provide needed flood storage. The landscapes of these watersheds are highly developed, but there are probably many historic wetlands that could be successfully restored, since restoration of former wetlands is generally considered to be more successful than creation.

In the Pawcatuck watershed, flood storage is not generally a problem because there are 21,782 acres of wetlands.[255] Many of these are large tracts of wetlands, like the 3,000-acre Great Swamp, which provides significant flood storage protection in the watershed. Mitigation efforts might concentrate on the restoration of degraded or functionally impaired wetlands. Through the restoration of salt marshes that have been converted to freshwater wetlands through anthropogenic causes like road building, the Net Primary Productivity[256] of these wetlands could be increased. Since much of South

[254]Tiner, Ralph W, .1989.

[255]In Rhode Island part of the Pawcatuck Watershed.

[256]Net Primary Production is defined as the amount of energy left after subtracting the respiration of primary producers, or plants, from the total amount of energy. It is the total amount of "food" available from the process of photosynthesis- the amount of biomass available to feed organisms, that do not acquire food though photosynthesis. From Environmental Encyclopedia.1994. Eds. Cunningham W.P. and Terence Ball. Gale Research Inc.

County has a tourist economy based upon access to aquatic resources, mitigation sites might be selected to increase wildlife habitat and recreational opportunities.

Finally, mitigation projects could be integrated with on-going restoration projects. The Guidance Document clearly states "mitigation credits may be given for activities undertaken in conjunction with, but supplemental to, other programs in order to maximize the overall ecological benefit of the conservation project."[257]

Models for this already exist in the state.[258] As discussed in chapter 2, the DOT is involved in a non-compensatory mitigation project to restore a salt marsh in Galilee, RI.[259] In this case it was judged that the DOT's participation in the restoration project served a greater good than its restoration of 7/10th of an acres of phragmites wetlands.

Net Gain of Functions

Compensatory mitigation projects should represent a net gain in socially valued wetland functions because wetlands are a public trust resource. While landowners can and do hold legal title to wetlands, the title is subservient to the government's fiduciary responsibility to protect wetlands for the public.[260] Under the public trust doctrine, only "the state has the authority to hold, modify, convey, or, in certain limited circumstances, to extinguish trust" responsibilities.[261] Recognizing this, the state has the duty to insure

[257]Guidance Document, p. 58608. part 2.

[258]Another example is that Federal and Rhode Island officials recently reached a $3 million settlement with 18 companies and individuals to resolve cleanup of a RI Superfund site. The settlement includes $525,000 for wetlands restoration projects along the Blackstone River. Providence Journal 2/20/1997.

[259] Work Begins to Revive Salt Marsh in Galilee. Providence Journal Bulletin. 10/16/96.

[260]Sarahan, Pauk.1994. Wetlands Protection Post-Lucas: Implications of the Public Trust. 13 Va. Envtl.L.J. 537-574. p. 557.

[261]Acher, J.H. and Terence W. Stone. 1995. The Interaction of the Public Trust and the "Takings" Doctrines: Protecting Wetlands and Critical Coastal Areas. Vermont Law Review. Vol. 20:81-115,p. 83.

that any compensatory mitigation project represents at minimum, no net loss of wetland functions and ideally a net gain in a public good like flood storage or wildlife habitat.

The Galilee project that the DOT is participating in almost certainly represents a net gain in wetland functions. Since phragmites wetlands are indicative of a distributed and low functioning wetland, the 60 acres of salt marsh restored will provide much greater wetland functions then the lost $7/10^{th}$ of an acre of phragmites wetlands. In this case, the publics trust resources lost through the destruction of the phragmites swamp are balanced against two public goods: the construction of the Jamestown Bridge and the restoration of a degraded salt marsh.

Decisions regarding compensatory wetland replication projects should be made cautiously. The inherent uncertainties of replication must be considered. Naturally existing wetlands should always be valued more highly than replicated wetlands, since ecosystem management is an uncertain science. There are no guarantees of the long term provision of wetland functions from anthropogenically altered wetlands. Also, existing wetlands may in the future provide functions that are not currently valued by society. Consideration should be given to possible option values[262] of existing wetlands before allowing functional trades to occur.

Extension of Protection: Functional Mitigation

Many functions lost in the state are no longer the result of the direct filling of wetlands but result from landscape level pressures. While the DEM controls point source discharges and the physical alterations to wetlands, the DEM can not control land use

---

[262]Options values are placed on environmental resources if the future benefits they might yield are uncertain and depletion of the resource is effectively irreversible. Given the limited nature of the understanding of wetland functions, options values must be considered.

patterns within watersheds that may adversely impact wetland functions.[263] Recognizing the national trend in wetland management towards the valuation of wetlands based upon functions, this section proposes how a mitigation banking system could be utilized to require compensatory mitigation for functional degradations.

Legal protection over functional impacts already appears to exist in the Freshwater Wetland Act. The Act reads in part:

> 7.01 General
>
> 1. Projects or activities taking place outside of freshwater wetlands which in all likelihood, due to their close proximity to wetlands or due to size or nature of the project or activities will result in an alteration of the natural character of any freshwater wetland, require a permit from the Director. Such projects generally include those which:
>
> a) Result in the change to the normal surface run-off characteristics which increase the rate and/or volume of water flowing into or draining or diverting water away from, freshwater wetlands by such activities as:
> creating or significantly increasing impervious surface areas;
> modifying run-off characteristics by grading significant amounts of land area or clearing and permanently modifying significant amounts of vegetative cover or areas draining into freshwater wetland;
> diversion of a concentration of surface run-off through swales, ditches, grading, drainage systems and other surface run-off conveyance systems to or away from freshwater wetlands;[264]

Thus, it is within the scope of the DEM legislative mandate to extend jurisdictional authority to functional degradation of wetlands. Permit requirements for projects resulting in functional impacts could include compensatory mitigation for functional degradations.

---

[263]Scott Millar.1992. Land Use as it Relates to Water Quality and Wildlife Habitat in Narragansett Bay Watershed. Rhode Island Division of Planning, NBP-92-97.

[264]RI Gen. Laws @ 2-1-21

A model for use of mitigation banking to compensate for the impact to functions associated with wetlands has occurred in other states. In New Jersey, the Public Service Electric and Gas Company (PSE&G) is in the process of restoring 10,000 acres of wetlands along the Delaware River to compensate for the fish killed during the cooling process at PSE&G power plants.[265] What is unique in this case is that PSE&G is not mitigating for wetland conversions but using wetlands to mitigate for the destruction of fish, a public trust resource.

In the context of Rhode Island, activities that degrade public goods could require permitting and compensatory mitigation. The Blackstone River Heritage Corridor Plan has warned that increased amounts of impervious surface in the watershed will result in a higher volume and rate of stormwater runoff;[266] if increases in impervious surfaces could be shown to "result in the change to the normal surface run-off characteristics which increase the rate and/or volume of water flowing" to or away from a wetland, then such activity could require a permit. Terms of this permit could include compensatory mitigation of flood storage. Flood storage should be viewed as a public trust resource, as such the state should require compensation for the degradation of this watershed function.

Conclusion

---

[265]Rogers, J.W.1996. "Wetland Mitigation Banking and Watershed Planning". p.177 .In. Mitigation Banking: Theory and Practice. Eds. Marsh,L.L. and Douglas Porter. Urban Land Institute.

[266]Cultural Heritage and Land Management Plan for the Blackstone River Valley National Heritage Corridor. .1990. State Guide Plan Element 131.

Proponents of mitigation banking promote wetland replication as an “integral part of watershed plans, facilitating ecological restoration and economic development”.[267] The five recommendations presented could aid in the integration of mitigation banking with the overall goals of watershed management and restoration plans.

1. Naturally occurring wetlands should always be valued over replicated wetlands, strict sequencing requirements should be maintained.
2. Wetland replication science and technology is limited, only projects with the highest likelihood of success should be attempted.
3. Mitigation should be integrated with watershed planning by assessing the watersheds functional needs
4. Compensatory mitigation projects should represent a net gain in socially valued wetland functions.
5. Mitigation banking could be utilized as a means of extending wetland to the protection of wetland functional quality, insuring that socially valued functions are protected.

Replication of wetlands is a risky and uncertain business, and should be undertaken with extreme caution.

[267]Rogers, J.W.1996.

Conclusion

In the late twentieth century in Rhode Island, ecosystems must be actively managed. Rhode Island's environment has been severely altered by anthropogenic land use since colonial times. As the American birthplace of the industrial revolution and as the nation's second most densely populated state, Rhode Island has lost its pristine nature. Wetlands continue to exist in the state because they serve functions that are valued by society. Whether the wetland function is the protection of property from flood damage or recreational opportunities derived from aquatic bird watching, wetlands provide public goods to the citizens of Rhode Island.

Wetlands are complex ecosystems that are only now beginning to be understood. Replication of these ecosystems is tenuous and there is little evidence to suggest that the majority of wetland types in Rhode Island are replicable. Any mitigation banking system in Rhode Island that seeks to balance developmental concerns with ecological concerns must recognize the limitations of wetland replication science and technology.

Proponents of mitigation banking suggest that it is preferable based upon regulatory and on-site replication failures. These advantages relate to regulatory failures to monitor replicated wetlands or scientific limitations associated with wetland replication science. It is in this context that state and federal agencies chose mitigation banking. Mitigation banking is the lesser of two evils; regulatory agencies recognize that without mitigation banking many wetland impacts may never be compensated for.

However, this is not the case in Rhode Island, where there are minimal permitted wetland impacts. Rhode Island is not permitting the conversion of significant amounts of wetlands. It would be short sighted for the state to retreat completely from its current strong legal protection of wetland resources.

Mitigation banking is not an ideal system in terms of ecology; it results from the need to balance development interests with the provision of public goods from wetland functions. Since there are no guarantees of the success of any replication, it must be viewed of as part of a loosening of wetland regulations in Rhode Island.

Certain wetland impacts will always occur, roads will be built or widened, gas pipelines and cable television wires will be buried altering wetlands. For such linear impacts, centralized mitigation sites are sensible. However, it is not these wetland impacts which will drive the political process and will bring mitigation banking to Rhode Island. Many advocates of mitigation banking will attempt to use it as a means of loosening wetland regulation to drive development interests.

Wetlands are not invasive, they occur in the landscape where there are complex sets of ecological variables. Moving wetlands around the landscape is a difficult and risky business. While probably not impossible, it is improbable that replication sites will replace all lost wetland functions.

At its best, mitigation banking is part of "the task to become a co-worker with nature in the reconstruction of the damaged fabric...reclaiming lands laid waste by human improvidence or malice".[268] At its worst, wetland mitigation banking is indicative of humanity's hubristic belief in its ability to improve upon nature. If mitigation banking does come to the state, the five recommendations presented in the previous chapter would help to insure mitigation banking be a positive mechanism for managing wetlands. The most important element of these recommendations is that naturally occurring wetlands are always more highly valued then replicated wetlands.

[268]George Perkiness Marsh, Man and Nature .1864. in Uncommon Ground: Rethinking the Human Place in Nature. p. 110. ed. William Cronon. W.W. Norton & Company, New York.1996.

Bibliography

Acher, J.H. and Terence W. Stone. 1995. "The Interaction of the Public Trust and the 'Takings'Doctrines: Protecting Wetlands and Critical Coastal Areas". Vermont Law Review. Vol. 20:81-115,p. 83.

Adamus, P.1986. The Cumulative Impacts of Development in Southern Maine: Wetlands, Their Locations, Functions, and Value. Maine State Planning Office

Adamus, P, Clairain, E.J., Jr., Smith, R.D., and Young, R.E. 1987. Wetland Evaluation Technique (WET): Volume I. Vicksburg, MS: US Army Engineer Waterways Experiment Station, .1987.

Adler, R.W.1992. "Addressing Barriers to Watershed Protection." 25 Envtl. Law. 973. Northwestern School of Law of Lewis and Clark.

Balter, R. 1994. Procedure to Predict the Impact of Hydric Modifications by Highways on Wetlands (Interagency Agreement with U.S.G.S.) FHWA-USGS Contr. No. 83-Y-10063. Diaog Agu No. 388609.

Beeftink, W.G. 1977. "Salt Marshes", p 93-121. In R.S.K. Barnes (Ed.) The Coastline. John Wiley & Sons, London.

Belt, C.S.1973. "The 1973 Flood and Man's Constriction of the Mississippi River", 189 Science 681.

Berry, J.F. and Dennison M.S .1993. Wetlands: Guide to Science, Law and Technology Noyes Publications. Park Ridge, New Jersey, U.S.A.

Boto, K.G. and William H. Patrick, Jr. "Role of Wetlands in the removal of Suspended Sediment." In Wetland Functions and Values: The State of Understanding, Phillip E. Greeson, ed. Minneapolis: The American Water Resources Association .1978.

Commercial Wetland Mitigation Credit Ventures: 1995 suvery.1996. IWR Report 96-WMB-9. Institute for Water Resources. U.S. Army Corps of Engineers.

Comprehensive Conservation and Management Plan for Narragansett Bay. 1992 .State Guide Plan Element 715, Report Number 71. Narragansett Bay Project

Corbitt, R.A. and Paul T.Bowen .1994. Constructed Wetlands for Wastewater Treatment. In. Applied Wetlands: Science and Technology. Ed. Donald M. Kent Lewis Publishers.

Costanza, R., Farber, S.C. and J. Maxwell .1989. Ecological Economics, Vol. 1, pp. 335-361.

Cowardin. L.M, Carter, V., Golet, F.C. and Edward T. Laroe .1979. Classification of Wetlands and Deepwater Habitats of the United States U.S.Fish and Wildlife Service.

Cultural Heritage and Land Management Plan for the Blackstone River Valley National Heritage Corridor.1990. State Guide Plan Element 131.

Dahl, T.E. 1990. Wetlands losses in the Untied States 1780s to 1980s. Washington, D.C: U.S. Department of the Interior, Fish and Wildlife Service.

Daukas, P., Lowry, D. and William Walker. 1989. "Design of Constructed Wetlands for Treatment of Stormwater Runoff from a Regional Shopping Mall in Massachusetts" in Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Donald Hammer., Ed. Lewis Publishers.

Dellfino, J.J. and H.T. Odum.1993. "Wetland Retention of Lead from a Hazardous Waste Site". Bulletin of Environmental Contaminant and Toxicology. 51(3):430.

Desbonnet, A. and V. Lee .1991. Historical Trends, Water Quality and Fisheries, Narragansett Bay. The University of Rhode Island Coastal Resource Center. Contribution No.100 and National Sea Grant Publication #RIU-T-91-001, Graduate School of Oceanography, Narragansett, RI.

Elliot, W. 1985. Implementing Mitigation Policies in San Francisco Bay: A Critique. California State Coastal Conservancy. 46 pp.

Enser, Richard .1988. "Wetlands Amendment," Ocean State Outdoors, Recreational and Conservation Strategies for Rhode Island. Division of Planning and Development, RI Department of Environmental Management.

The Environmental Working Group. "Comments on the Proposed Reissuance of the U.S. Army Corps of Engineers' Nationwide Permits." http://www.ewg.org/pub/home/reports/nwp/nwp_contents.html, 20 March 1997.

EPA.1995. Wetlands Fact Sheet, Office of Wetlands. EPA843-F-95-001b.

Farrell, A.P., Comment, "Agricultural Non-Point Source Pollution and Wetlands: A Sensible Approach". 1 Mo.Environmental. Law and Policy Review.74. 74-75.

Federal Emergency Management Agency.1995. National Mitigation Strategy.

Federal Guidance for the Establishment, Use and Operation of Mitigation Banks. Federal Register, Vol. 60, No. 228. 10/28/1995.

Feierabend, J.S.1992. Endangered Species-Endangered Wetlands: Life on the Edge. National Wildlife Federation, Washington D.C.

Foreman, D.1993. Ecodefense: A Field Guide to Monkey Wrenching. New York: Abbzug Press.

Gambrell, R.P. 1994. "Trace and Toxic Metals in Wetlands: A Review". Journal of Environmental Quality. 23: 298-305.

Gersberg, Richard M. and Mike Ives.1989. "Pathogen Removal in Constructed Wetlands" in Constructed Wetlands for Wastewater Treatment: Municipal, Industrial and Agricultural. Donald Hammer., Ed. Lewis Publishers.

Gold, Arthur and Robert Simmons. 1990. "Groundwater Studies" in An Investigation into Multiple Uses of Vegetated Buffer Strips, Narragansett Bay Project Report. Providence, RI.

Golet, F.C.1986. "Critical Issues in Wetland Mitigation: A Scientific Perspective". National Wetlands Newsletter 9-10. p.6.

Golet, F.C. and James Parkhurst.1981. "Freshwater Wetland Dynamics in South Kingston, Rhode Island, 1939-1972". Environmental Management, 5, No. 3, 245-251.

Gosselink, J.G., W.H. Conner, J.W. and R.E. Turner. 1981. "Classification Wetland Resources; Land, Timber, and Ecology". *In:* B.D. Jackson and J.L. Chambers (eds.) Timber Harvesting in Wetlands. Louisiana State Univ., Baton Rouge, L.A.

Halverson, W.L. and Gardiner, W.E, ,1976. Atlas of Rhode Island Salt Marshes. University of Rhode Island Marine Memorandum No.44

Hey, D.L., and Philippi, N.S. 1995. "Flood reduction through wetland restoration: The Upper Mississippi River Basin as a case history". Restoration Ecology 3:4-17.

Hosomi, M.A. and R. Sudo.1991. "A Four-Year Mass Balance for a Natural Wetland System Receiving Domestic Wastewater". Water Science Technology. 30(8): 235-244.

Houck, Oliver A.1989. "Hard Choices: The Analysis of Alternatives Under Section 404 of the Clean Water Act and Similar Environmental Laws". 60 U.Colo. L. Rev. 733, 774-775

Houck, Oliver A. and Michael Rolland.1996. "Federalism in Wetlands Regulations: A Consideration of Delegation of the Clean Water Act Section 404 and Related States Programs". Maryland Law Review. Vol.54.

James City County v. EPA. 12 F.3d 1330 (4th Cir.1993)

Jewell, William J.1994. "Resource-recovery and Wastewater Treatment". American Scientist, vol.82, 366-75.

Johnson, Carol A.1991. "Sediment and Nutrient Retention in Freshwater Wetlands: Effects on Surface Water Quality". Critical Reviews in Environmental Control. 21 (5,6): 491-565.

Klopatek, J.M.1978. "Nutrient Dynamics of freshwater riverine marshes and the role of emergent macrophytes". *In*. R.E. Good, D.F. Whigmen, and R.L. Simpson (eds.) Freshwater Wetlands. Ecological Processes and Management Potential. Academic Press, New York.

Kobriger, N.P.1991. Effects of Highway Runoff on Wetlands. Final Report. National Cooperative Highway Research Program Report. No. 264. 353 pp.

Kusler, J A. and Mary Kentula.eds.1990. Wetland Creation and Restoration: the statues of the science, Island Press, Washington D.C.

Kusler, J.A.1990. Issues in Wetland Protection, National Wetlands Policy Forum The Conservation Foundation.

Larson J.S. and Christopher Neill, eds.1986. Mitigating Freshwater Wetland Alterations in the Glaciated Northeastern United States: An Assessment of the Scientific Base. The Environmental Institute: University of Massachusetts at Amherst.

Maguire, C.E. 1985. Wetland Replacement Evaluation. U.S. Army Corps of Engineers, Norfolk District. Contract No. DACW-65-85-D-0068. Norfolk, V.A. 188 pp.

Marks, Eugenia.1989. A Case Study in Environmental Policy: Administration of the Rhode Island Freshwater Wetlands Acts. Master's Thesis: Brown University's Center for Environmental Studies.

Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404 (b)(1) Guidelines.1992

Metzer, K.J. and R.W. Tiner .1992. Wetlands of Connecticut U.S. Fish and Wildlife Service, Washington, D.C.

Miller, G.T.1997. Environmental Science. 6th ed. Wadsworth Publishing Company

Mitsch, W.J. and J.G. Gosselink .1993. Wetlands. New York: Van Nostrand Reinhold.

Moyer, S. & Feierabend J.S.1991. National Wildlife Federation, Statement of National Wildlife Federation Before the Subcommittee on Environmental Protection and Federal Wetlands Legislation 13.

Narragansett Bay Method: A Manual for Salt Marsh Evaluation .1996. Save the Bay

National Audubon Society.1994. Valuing Wetlands: The Cost of Destroying America's Wetlands, 29 Deanne Kloepfer ed.

National Wetland Mitigation Banking: Resource Document.1994. IWR Report 94-WMB-2. Institute for Water Resources. U.S. Army Corps of Engineers.

National Wildlife Federation, Wetlands Are Vital to Protecting Our Nation's Water Quality .1993.

Nationwide Personal Transportation Survey.1990. (NPTS) U.S. Department of Transportation. Prepared by U.S.Bureau of the Census.

Neiring and Warren .1980. Vegetational Patterns and Processes in New England Salt Marshes.

Office of Strategic Planning: Division of Planning, Department of Administration.1995. Rhode Island: Commercial Fisheries: Economic Adjustment Strategy.

Office of Technology Assessment, U.S. Congress, Wetlands, Their Use and Regulation 48-52 .1984.

Pennsylvania Coal Co. v. Mahon, 260 U.S. 393 .1922.

Redmond, A.M.1995. "Florida Moves to Mitigation Banking". National Wetlands Newsletter. Nov-Dec. 14-19.

Rhode Island Division of Planning.1989. Land Use 2010: State Land Use Policies and Plan. State Guide Plan Element 121.

RIDEM.1988. Assessment of Non-point Sources of Pollution to RI Water. Office of Environmental Coordination. Providence, RI.

RIDEM.1994. State of the State's Waters 305 (b) Report. Office of Environmental Coordination. Providence, RI.

Marsh, L.L. and Douglas Porter, Eds.1996. Mitigation Banking: Theory and Practice. Urban Land Institute.

Millar, Scott.1992. Land Use as it Relates to Water Quality and Wildlife Habitat in Narragansett Bay Watershed. Rhode Island Division of Planning, NBP-92-97

Sarahan, Paul.1994. "Wetlands Protection Post-Lucas: Implications of the Public Trust". 13 Va. Envtl.L.J. 537-574. p. 557

Scodari, P.F.1990. Wetlands Protection: The Role of Economics. Environmental Law Institute

Short, Cathleen.1988. Mitigation Banking, Biological Report 88(41). U.S. Department of Interior.

Smith, R Daniel.1996. "An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification Reference Wetlands, and Functional Indices." Wetlands Research Program Technical Report WRP-DE-9. United States Army Corps of Engineers.

State of Rhode Island: Coastal Resources Management Program. 1977. As Amended

Strouded, Richard H .1992. National Coalition for Marine Conservation, Stemming the Tide of Coastal Fish Habitat Loss. Proceedings of a Symposium on Conservation of Coastal Fish Habitat.

The Scituate Watershed Reservoir Watershed Management Plan. Rhode Island Division of Planning.1990. State Guide Plan Element 125.

Thibodeau, F.R. and D.B. Ostro.1981. "An Economic Analysis of Wetlands Protection". J. Environmental Management . 12:19-30.

Tiner, R.W.1984. Wetlands of the Untied States: Current Status and Recent Trends. National Wetlands Inventory Project. Washington, D.C.: U.S. Fish and Wildlife Service.

Tiner, Ralph W.1989. Wetlands of Rhode Island. U.S. Fish and Wildlife Service, National Wetlands Inventory, Newton Corner, MA.71 pp.+ Appendix

U.S. Army Corps of Engineers.1995. Section 404 of the Clean Water Act and Wetlands: Special Statistical Report U.S. Army Corps of Engineers Regulatory Branch.

U.S. Fish and Wildlife Service.1989. National Wetlands Priority Conservation Plan 22

U.S. Fish and Wildlife Service.1981. Ecological Services Manual, Standards for the Development of Habitat Suitability Index Models 103-ESM-1-2.

U.S. Secretary of the Interior. The Impact of Federal Programs of Wetlands: The Lower Mississippi Alluvial Plain and the Prairie Pothole Regions.1988.

United States Department of the Interior.1989. Section 301 of the Emergency Wetlands Resources Act of 1986 (USC Section 3921)

US Army Corps of Engineers: New England Division.1989. Evaluation of Freshwater Wetland Replacement Projects in Massachusetts

Lee, Virgina.1996. Integrated Multi-Hazard Mitigation In Rhode Island. Coastal Resource Center, South Kingston, R.I.

Want, William L.1989. Law of Wetlands Regulation Section 2.01 (3)

Weinberg, Alvin A.1972. “Science and Transcience”. 10 Minerra 209.

Wetland Mitigation Banking. IWR Report 94-WMB-6.

Wetland Mitigation Banking: First Phase Report. IWR Report 94-WMB-4.

Wetlands Mitigation Banking In Massachusetts. Report and Recommendations of the Wetlands Restoration & Banking Advisory Committee to Massachusetts Secretary of Environmental Affairs Trudy Coxe. August 22,1995.

Wetlands: characteristics and boundaries .1995. Committee on Characterization of Wetlands: National Research Council.

Wetlands: Mitigating and Regulating Development Impacts .White House Office of Environmental Policy.1993. *Protecting America’s Wetlands: A Fair, Flexible and Effective Approach..*

White, T.A., Blaire, C.L. and Keith B. MacDonald.1992. “Wetland Replacement: The Art and Science of Renewing Damaged Ecosystems”. Renewable Resources Journal.

Woonsocket Industrial Highway/ Route 99 : Wetland Replication Monitoring. Prepared by Vanasse Hangen Brustlin, Inc.

Zedler, J.B.1996. "Ecological Issues in Wetlands Mitigation: An Introduction to the Forum". Ecological Applications, 6(1). pp.33-37

Appendix A: Maps