GAMBLING WITH THE SHORE

PROCEEDINGS OF NINTH ANNUAL CONFERENCE

Published By

THE COASTAL SOCIETY
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OF

NINTH ANNUAL CONFERENCE

GAMBLING WITH THE SHORE

ATLANTIC CITY, NEW JERSEY

14-17 October 1984

EDITOR: M. P. LYNCH

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FOREWARD

The Coastal Society held its Ninth Annual Meeting in Atlantic City, New Jersey, October 14-17, 1984. The title of the Conference (and these Proceedings), Gambling With the Shore, was relevant to both the site and theme of the Conference.

A thread that runs through many of the sessions and individual papers is that of risk. Risk is inherent in the game of life, but those that play the game on the shore do so on a game board that is constantly shifting with rules that change. For those with a good understanding of the rules and a feel for the strategy of play, gambling with the coast can be stimulating, challenging and rewarding. Those that don't understand the rules and who never understand how to play invariably wind up losers.

The functions of The Coastal Society include keeping track of the game board and rules and training effective players. This Proceedings volume is an attempt to clarify the rules and define the game board as we know them today. It contains valuable information for both expert and novice players. In gambling with the shore whether you win or lose depends upon how you play the game.

There has been some rearrangement of papers in the Proceedings, primarily in the distribution of poster session papers to related topical sessions and the assigning of a topical heading to the remaining poster sessions.

I wish to thank those individuals that contributed to these Proceedings and to the success of the meetings by attendance at the sessions, presentation of papers and participation in discussions.

I wish to acknowledge the particular efforts of Ms. Karen McDonald, Mr. William Reay and Ms. Claudia Walthall for their assistance in preparing these Proceedings for publication.

M. P. Lynch
Proceedings Editor

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COMPETING USES OF WATERFRONT PROPERTY IN THE PORT OF NEW YORK AND NEW JERSEY

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> "..Commerce has the first claim on the New York waterfront, but no one will dispute that some of it should be saved for the pleasure and refreshment of the people." NEW YORK SUN, OCTOBER 1853

The Port of New York and New Jersey, traditionally considered the nation's premier harbor, encompasses more than seven hundred miles of waterfront property. The port complex, located seventeen miles from the open sea, is well protected from storms and not subject to extreme weather conditions which might hinder maritime activities. Over several decades, activity along the shoreline has adapted to the technological changes in the maritime industry, as well as the population dynamics of the metropolitan area.

Historically, the waterfront provided a transportation route for commuters, facilities for municipal services, terminals for import and export activities, shipbuilding and ship repair yards, and marine supply warehouses. The commercial heritage of the port began in 1698 when a monopoly was granted for the baking of bread for export. By 1840, the East River had 60 wharves, and the Hudson River 53. The East River remained the principal water route until the invention of the steamboat and an increase in water traffic on the Hudson River. The wharves on the New Jersey side were initially constructed in 1847 and by the 1900's there was extensive port development in both Brooklyn and New Jersey. Federal programs to improve rivers and harbors commenced in 1834 with the first U.S. Army Corps of Engineers civil works project in the Upper Hudson River.

The main channel was first dredged in 1884 and the East Channel, renamed the Ambrose Channel, was improved in the early 1900's. Today, there are forty-four authorized Federal channels which provide access to 1,300 waterfront complexes, more than 200 deep draft facilities and over one million linear feet of berthage within the Port. Port Newark, Port Elizabeth, Howland Hook, South Brooklyn Terminal, Global Marine Terminal and Red Hook Terminal represent the nation's largest and most successful container and general cargo facilities. The maritime industry generates $1.7 billion in business income, $7.7 billion in sales revenue, 190,000 employment opportunities with a $4.2 billion dollar payroll and $332 million in combined federal, state and local taxes.

The metropolitan area surrounding the Port of New York and New Jersey not only constitutes the home of the world's most dynamic port, but also the largest concentration of people in the nation. A variety of shoreside facilities are needed to provide the metropolitan area with goods and services. There are several hundred bulk petroleum storage facilities located throughout the harbor with a full complement of tugs and barges for transshipment to refining and and distribution centers. There are a dozen marine transfer stations and staging areas for the transportation of solid wastes to disposal sites; several treatment plants to process sewage; and a number of fireboat and marine police stations to insure adequate protection for waterfront facilities. In addition, the federal government maintains a number of waterfront complexes for the United States Coast Guard, Army, Navy, Corps of Engineers and Customs Service. In essence, the population dynamics of the Port of New York and New Jersey have necessitated the development of shoreside facilities to accomodate the needs and provide for the well-being and protection of its residents, as well as to facilitate economic growth in the northeast region of the United States.

The advent of containerization rendered a number of finger piers, structures erected on piles and perpendicular to shoreline, on both sides of the Hudson River, obsolete. Consolidation and reorganization of rail service in the region has resulted in the abandonment of major portions of the New York and New Jersey waterfront south of the George Washington Bridge. The development of more efficient modes of transportation for commuters between the two shorelines has resulted in the disappearance of trans-Hudson railroad and ferry service. As facilities were consolidated and waterfront areas abandoned many shoreside structures fell into a state of disrepair which would only worsen with the impact tide and time. For at least a decade, much of this impacted shoreline remained dormant. Spurred by an easily transversed waterway and an interest in dwelling in close proximity to one's job, the waterfront areas are now enjoying renewed interest on the part of real estate developers. The unobstructed view from the water's edge has, once again, proved to be a lure for city and suburban dwellers.

Today, the port region faces the most interesting challenges with respect to development along the water's edge. Several laws enacted in the 1970's have had, and will continue to have, a profound effect on waterfront development. Congress passed the Coastal Zone Management Act (CZMA) in 1972 with the stated goal of furthering "a national interest in the effective management, beneficial use, protection, and development of the coastal zone." The CZMA has been amended three times since 1972, most recently in 1980. Prior to 1972, a few coastal states had enacted or were preparing comprehensive coastal plans, while many others had passed legislation regulating specific uses of the coastal zone. The Coastal Zone Management Act went a step further by encouraging states to adopt more comprehensive plans and resource allocation procedures. State management programs developed under the Act's guidelines highlight flexible approaches available to states in managing the coastline.

In New York State the Department of State has responsibility for the implementation of the CZM program. New York State and New York City plans were formally approved in September 1982 with the enactment of the Waterfront Revitalization Act. The Act outlines ten principles in its definition of "waterfront revitalization"; namely:

1) Development of existing ports and harbors

2) Promotion of commercial and recreational use of fish and wildlife resources

3) Balancing economic development and preservation of marine resources

4) Encouraging public access for recreational purposes

5) Minimizing damage due to flood and erosion

6) Restoring and revitalizing natural and man made resources

7) Encouraging land development where infrastructure and public services exist

8) Conserving and protecting agricultural lands

9) Assuring consistency of state and federal actions with policies

10) Coordinating policies with other states

In addition, New York City identified special management areas, erosion/flood hazard areas, shorefront access areas, special zoning districts and geographic areas of particular concern.

The New Jersey program was developed in two parts, with the lead agency designated as the Department of Environmental Protection. The first part, called the Bay and Ocean Shore Segment, was approved in September 1978. The second part focuses on New Jersey's other tidally influenced waterfront areas in the Hackensack Meadowlands and along the Hudson and Delaware Rivers. Both segments outline basic policies to be applied in the coastal program; namely, to:

1) Protect and enhance the coastal ecosystem

2) Concentrate the pattern of commercial, residential, industrial, and resort development and encourage the preservation of open space

3) Develop a method of decision-making which allows each coastal location to be evaluated

4) Protect the health, safety, and welfare of people who reside, work and visit the coastal zone

5) Promote public access to the waterfront through linear walkways with at least one waterfront park in each waterfront municipality

6) Maintain active port and industrial facilities and provide for necessary expansion in adjacent sites

7) Maintain and upgrade existing energy facilities and site additional facilities as needed

8) Encourage residential, commercial, recreational mixed-use redevelopment of the developed waterfront

Both New York and New Jersey implement their coastal zone management plans through a series of permit proceedings, inter-agency review and consistency certifications. Both programs appear to have taken into consideration all potential uses of the waterfront with due deference paid to existing industrial, commercial and water dependent uses.

Today, new uses are proposed for the shoreline; floating resturants, condominums, esplanades, hotels and marinas. The extent to which all of the above can be accomodated along the expansive, yet thin, strip of land which defines the shoreline will clearly influence maritime activity within the Port District.

The New York-New Jersey Hudson River waterfront is currently the focus of major development projects which will inevitably alter the water's edge. New Jersey's lower Hudson riverfront, stretching 18.5 miles south of the George Washington Bridge, is essentially an abandoned waterfront area. Several major developers have acquired more than 1,000 acres located within minutes of Manhattan and commanding a spectacular view of the New York skyline. Plans have been announced for offices, apartments, marinas, shopping centers, amusement and cultural attractions. The implementation of all the proposals would result in locating 100,000 residents on the narrow strip of land between the Palisades and Bayonne.

The New Jersey proposals focus on ten sites located between the townships of Edgewater and Bayonne. In Edgewater, the Alcoa and Ford plants, now inactive, would be converted to 1,400 housing units, including facilities for parking, marinas and a resturant. In North Bergen, a proposal for the construction of 679 housing units has been submitted. In West New York/Weehawken, which includes over 300 acres spanning two miles of waterfront property, a proposal for the development of residential and commercial complexes is under evaluation. Hoboken may be the future site of residential units, office buildings, shopping mall and a marina. In Jersey City, a proposal calls for the development of a regional shopping mall, offices, 1,000 residential units and a marina. Jersey City has received proposals for five different waterside sites which include a riverfront plaza, passenger terminal for transport to Liberty State Park, a science and technology center, a luxury hotel, 2,000 slip marina, 3,000 residential units and a coal export facility.

On the New York City side of the Hudson River, Spuyten Duyvil to the Battery, no less than seven major construction projects are in the planning stage. Many of the projects include "mixed-use" development, that is residential complexes, office towers, parks, resturants and esplanades. Beginning at the Battery,New York State Legislation passed in 1982 established the New York City Harbor Park, consolidating Battery Park, Liberty Island, Ellis Island, South Street Seaport, Fulton Ferry and Sailor's Snug Harbor. The rehabilitation of docking facilities and subsequent ferry transportation to the park complex is in the planning stage. Battery Park City, currently under construction, will be the site of three apartment houses, four office towers and a 1.2-mile esplanade. From Battery Park north to West 35th Street, a highway is proposed and will include a 93-acre linear park, housing, retail and light industry. The U.S. Army Corps of Engineers is currently evaluating a permit application for the prerequisite landfill to implement the construction of the highway dubbed "Westway". A Convention Center is under construction between West 33rd to 39th Streets. The Center will encompass a 1.8 million square foot structure with a landscaped plaza. New York City is seeking proposals for the development of a commercial and hotel facility on the waterfront to complement the Convention Center. Lincoln West, from 59th to 72nd Streets, may be the site of seven residential towers, restaurants, offices and shopping. Riverside Park, from 72nd to 129th Streets, is scheduled to undergo landscape restoration and improvement. Finally, Riverbank State Park is proposed as a 28-acre park decking the North River waste water treatment plant currently under construction.

To a large extent, the proposals for the shoreline of the New Jersey and New York Lower Hudson River come as a refreshing change in the view with which the metropolitan area has regarded the waterfront. For nearly two centuries the waterfront has been viewed, from a respectable distance, as a noisy, seedy and undersirable locale. The presence of industrial facilities, ships, warehouses and freight yards were better left out of sight of the "landed gentry." However, the national trend towards the "gentrification" of urban waterfronts has resulted in a renewed interest in the water's edge. The questions posed by all of the development projects outlined is not whether the waterfront areas should be developed to provide housing, parks and commercial facilities, but rather, whether or not there will be room for and tolerence of activities which were once regarded as noisy, seedy and undesirable. Will the the sand, gravel and batching facility be deemed necessary only until the completion of a construction project? Will the marine transfer station be eventually viewed as an eyesore? Will the "gentrification" of the waterfront result in precluding the siting or expansion of a water dependent facility?

The Coastal Zone Management Programs, both Federal and State, will play an influential role in the development of the waterfront. Each and every proposal is subjected to a rigorous review prior to the issuance of a permit for construction. There are several issues which must be thoughtfully evaluated to protect the public and the maritime industry.

The "public access" doctrine, found in both the New York and New Jersey policies, dictates that waterfront parcels be set aside for esplanades, bikepaths and parks. Clearly, the designation of a "public access" area must be accomplished without inhibiting the port's primary function--navigation and commerce. The recreational use of waterfront areas must be compatible with the reasonable and recognized needs of the maritime industry. Sufficient and adequate space for extended industrial uses must be preserved. Public safety and security must be taken into consideration. In some cases, recreational use of waterfront parcels may pose a danger to the public (railroad tracks, extensive traffic, truck or marine terminal equipment), a threat to the security of a facility as well as a liability for a property owner who cannot anticipate the careless or criminal behavior of others. Where physical accessability is not possible or simply inappropriate, alternative means of providing "public acess" should be considered. Preserving visual corridors, providing overlooks and viewing towers may prove to be the means by which to accomplish the goals of coastal zone management programs without infringing on the legitimate needs of water dependent industrial and commercial uses of the waterfront. Public access cannot be a priority where such access is clearly inconsistent with public safety or the operational needs of a maritime facility.

However, as alluded to earlier, the "gentrified" view of the waterfront may have an even more deleterious impact on the maritime industry. There are several industries within the port which are currently experiencing severe pressure to relocate to make way for what some regard as more lucrative and appealing development projects. A successful ship repair business is under pressure to make way for residential development. Towboat and barge operators are having difficulty siting a tie-up point at which to change crews and take on fresh water. Scrap metal facilities, marine transfer stations, resource recovery plants and import and export terminals are not viewed as desirable neighbors for luxury housing and hotel complexes. Certainly, any property owner seeks to develop a parcel for its "highest and best use", however, the displacement of maritime facilities may result in dire economic consequences for the entire port district. Many of the water dependent uses of the shoreline often require several locations throughout the harbor to efficiently and economically operate. Therefore, it is not simply a matter of relocating one particular facility to a new locale. Rather, the maritime industry and municipal services often require a number of sites, geographically dispersed and adjacent to deep water channels, in order to provide the goods and services that maintain the industry and support the economic vitality of the metropolitan area. Although condominiums, parks and restaurants may hold more appeal to the general public, there will be little, if any, harbor activity to view from the water's edge if we are collectively remiss in our responsibility to protect water dependent industries.

Perhaps recognition should be given to a "maritime zone" within which water dependent uses would enjoy priority over competing non-water dependent facilities or complexes. This concept is reflected in the designation of "geographic areas of particular concern" and "special zoning districts". The designation of areas exclusively reserved for maritime activities would help ensure that the Port of New York and New Jersey remains the nation's premier harbor. The designation of such areas would necessarily have to be flexible to accommodate the future consolidation of industrial uses or the possibility that such areas are not required by the maritime industry. The concept of a "first right of refusal" may suffice to provide adequate expansion areas for water dependent and related industries and to preserve the public's interest in the future redevelopment of the shoreline. Another approach would be to allow areas to be redeveloped for "public access" until such time that a maritime use of the parcel is identified. This approach may help to expediently reform vast stretches of the waterfront, but in the long run prove to be a political albatross for the maritime industry. At the very least, existing water dependent uses of the shoreline must be recognized, protected and afforded the opportunity to continue to serve the commercial, industrial and municipal needs of the metropolitan area. The States of New York and New Jersey and the Coastal Zone Management Program can assist the maritime industry in several ways:

- Setting land use policies that reserve strategic sections of the waterfront for maritime/industrial uses
- Funding infrastructure for existing and new maritime developments
- Offering tax incentives and/or financing programs for maritime/industrial development

A variety of options and a flexible approach must be identified in order to fulfill the aesthetic and recreational needs of the population and, at the same time recognize the navigation, shipping, commercial and industrial uses of the waterways. Linear walkways, viewing towers, waterside and landside facilities can all be provided concurrently with other shoreline and development projects. Liberty State Park, Battery Park and South Street Seaport are fine examples of providing "public access" for metropolitan residents and visitors. In addition, the full implementation of the New York City Harbor Park will complement the existing "water's eye view" of the metropolis.

Competing uses and plans for the waterfront can be complementary, provided a claim to the waterfront is balanced by a respect for the port's commercial heritage as well as the public's interest in a view from the water's edge.

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PROTECTING SAND DUNES: THE MAINE EXPERIENCE

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Background

Maine's coastal zone comprises only 12% of the State's land area, but over half of the State's population lives in this region. Of the almost 2.5 million acres of land in the 143 minor civil divisions that make up this coastal area, 96% is privately owned, leaving Maine the smallest percentage of coastal land in public ownership of any coastal state (Maine SPO, 1978). Between 1970 and 1980, there was a forty-three percent increase in population along the coast, so development pressures there are intense. Perhaps nowhere are they more intense than on Maine's sand beaches. Maine has a 3500 mile, heavily indented coastline, a legacy of the last ice age (U.S.DOC, 1978; Deis, 1982), but only 36 miles, or 1% of this land, is sand beach. These beaches are concentrated along the Southwestern coast of Maine (CCDC, 1978) in towns such as Wells and Old Orchard Beach, where summer visitors swell populations to three times their off-season numbers (U.S. DOC, 1978).

Maine's beaches have a classic barrier beach profile: a beach face subject to the ebb and flow of the tides--gently sloping in summer, steeper in winter--a berm (shelf) at the tideline, backed by a frontal dune, and then lower dunes, often backed, in their natural state, by salt marsh (Deis, 1978; Maine SPO, 1983). For the most part, these beaches are in recession, due largely to the world-wide rise in sea level, averaging almost an inch per decade along Maine's southwestern coast. But, as along much of the East Coast, this natural recession has been hampered by destruction of the dune system through human activities. By 1978 seawalls had been constructed along 14 miles or more than 1/3 of Maine's sand beaches and 62% of Maine's 1900 acres of sand dunes had been developed.

In January and February of 1978 two severe winter storms struck the Maine coast causing 47 million dollars worth of property damage, over half of it on Maine's sand beaches along the southern coast. In response to this widespread destruction the Governor's Advisory Committee on Coastal Development and Conservation produced a report entitled "Policy Recommendations for Reducing Costal Storm Damage." Among the report's seven recommendations were: 1) that Maine's Alteration of Coastal Wetlands Act (first enacted in 1967) be amended to regulate building of structures on sand dunes and accreted lands, and 2) that the Board of Environmental Protection's existing policy establishing a presumption against the construction of seawalls be continued unless and until it could be demonstrated that seawalls in specific locations were capable of providing long-term protection. Both of these recommendations were accepted (CCDC, 1978).

Legislation

In 1979, the Maine legislature passed "An Act to Allow the Board of Environmental Protection to Regulate Activities Affecting Sand Dunes under the Alteration of Coastal Wetlands Program" There was considerable support for the legislation from the general public and from coastal land-owners; although one mid-coast legislator, foreshadowing events to come, stated, "I think right now we are willing to live with this particular legislation, and I can assure you that in the future, if the State is unreasonable in its implementation of regulation of sand dunes, then certainly I will be back here or somebody else will be back here to ask for repeal." (Me. Leg. Rec., 1979)

The terms of the sand dune legislation are fairly simple. The first section prohibits any person from removing, adding, or displacing sand or building any permanent structure in, on, or over any coastal sand dune without obtaining a permit, or in violation of that permit once granted. Coastal sand dunes are defined as "sand deposits within a marine beach system above high tide including, but not limited to, beach berms, frontal dune ridges, beach dune areas, and other sand areas deposited by wave or wind action. Coastal sand dunes may extend into the coastal wetlands."

Under the permits section, the applicant has the burden of proving that the proposed activity will meet four standards, i.e., that it will not:

1) unreasonably interfere with existing recreational or wildlife uses

2) unreasonably interfere with the natural supply or movement of sand within or to the sand dune system

3) unreasonably increase the erosion hazard to the sand dune system

4) cause an unreasonable flood hazard to structures built in, on, or over any coastal sand dune or neighboring property. (38 MRSA §§ 471-476)

For four years after the passage of the Act it was administered without clarifying regulations. The "unreasonable" standard was broadly discretionary and the board routinely granted sand dunes permits for construction of homes. In fact, no applications for such permits were finally denied prior to the passage of implementing regulations (Hall v. BEP (1), 1984). Nevertheless, applicants, concerned about the uncertainty inherent in the broad statutory standards, sought clarifying regulations from the Board.

Regulations

The sand dune regulations, effective August 1, 1983, provide concrete standards. Some activities, such as maintenance and repair of various pre-existing structures, are exempt from the requirement to obtain a permit, provided the repaired structure does not differ significantly from the existing one and does not cause any greater impact on the sand dune system. But if the storm damage to a building exceeds 50% of the building's appraised value the owner must get a permit before rebuilding.

The regulations establish six regulatory standards applicable to all projects, compliance with which will ordinarily satisfy the four statutory standards for permit issuance. These six standards are:

1. Projects shall have a minimal impact on the immediate site and on the sand dune system. Impacts which may reasonably be expected to occur during the following 100 years will be considered. In areas where substantial portions of the dune system remain unaltered, special attention will be paid to the cumulative impacts of activities on the dune system.

2. Projects shall not be permitted if, within 100 years, the project may reasonably be expected to be damaged as a result of changes in the shoreline.

3. Projects shall not cause a flood hazard to any structure during a 100-year flood or storm.

4. Shore bird nesting or breeding areas or activities shall not be unreasonably disturbed by any project activities. Shore bird nesting or breeding areas shall be adequately buffered from subsequent human activities associated with the use of any project. Buffer requirements will be based upon the best available data.

5. Projects shall not interfere with legal access to or use of the public resources.

6. Disturbed areas of beach grass shall be revegetated with beach grass as quickly as possible. (MDEP, 1984)

These regulations are exemplary for several reasons. First, they limit what was virtually unfettered discretion under the statutory standards by defining what is "unreasonable." Second, the standards look to the future and set a time frame of 100 years. While this period may seem long, it makes sense in the context of the geological processes at issue; in evaluating the applicant's proposal, the Board can rely on scientific data regarding 100-year storms and the inch per decade sea level rise. Third, the first standard explicitly refers to cumulative impacts. The issue of how to deal with cumulative impacts, particularly in coastal and rural areas, is one of increasing concern for state planning agencies and regulators, who must grapple with questions of how far into the future and over what area one looks for cumulative impacts. Here the issue has been resolved in terms of time, and the small size of Maine's beaches makes the obvious unit of area the individual beach. Finally, the regulations specifically provide for protection of wildlife, a value sometimes neglected in wetlands and dune regulations where human concerns of water supplies, recreation, and aesthetics are more likely to first come to mind.

Additional regulations set specific standards for different types of projects: buildings, fences, fill, roads and driveways, seawalls, septic systems, walkways, beach nourishment projects, dune restoration projects, and movement of sand. Most notable of these are the strict regulations regarding buildings, and seawalls, the essentials of which follow.

For buildings:

> 1) No new building shall be constructed in the V-zone [the area subject to 100-year floods and high velocity wave action].
>
> 2) No new building or addition shall be constructed on or seaward of a frontal dune.
>
> 3) New buildings and additions in the A-zone [the 100-year flood zone] shall be constructed on posts so that the lowest portion of the structural members of the lowest floor ... is at least one foot above the elevation of the 100-year flood
>
> 4) Buildings reconstructed after being more than 50% damaged by an ocean storm must be no larger in surface area than the original building, must be relocated as far out of the A and V flood zones as possible, and if not completely outside these zones must meet the A-zone standards and must be certified by a Maine registered engineer or architect to withstand 100-year storms.

for seawalls:

> 1. No new seawalls shall be constructed in or on any sand dune system
>
> 2. Existing seawalls may be repaired and maintained provided that:
>
>   a. they protect existing services or utilities;
>
>   b. the original dimensions of the seawall are not altered; and
>
>   c. the construction materials and methods are not significantly altered. (MDEP, 1984)

Maine's prohibition of construction in V-zones is, according to NOAA, a nationwide precedent, going beyond the requirements and standards of the National Flood Insurance Act (U.S. DOC, NOAA, 1984). The reasons the stricter standards were chosen are that sea level is rising faster along the Maine coast than in many other parts of the world because the land is sinking both along the extreme eastern part of the coast and in

York County, where most of the sand beaches are. Thus it was felt that the V-zone in Maine was particularly vulnerable and that housing construction there would be unsafe--the houses perhaps being in the water in a matter of years. In addition, ownership patterns showed that with only a few exceptions most oceanfront lots in York County extend far enough into the A-zone to allow construction outside of the V-zone (Michaud, 1984).

It is notable that all scientific and expert commenters on the proposed regulations supported the prohibition on the construction of new seawalls or of new structures in the V-zone, because of their adverse impacts on the beach system posing severe flood hazards to the public (MDEP, 1984).

Litigation

With these regulations in place, providing a specific basis for denying permit applications, the number of denials of permits for buildings increased from one out of 72 permits for the first four years to four out of 35 permits during the year after the adoption of the regulations. The first permit to be denied was that of Donald and Virginia Hall, New Hampshire residents who owned property at Popham Beach. Prior to 1977, there were two cottages on the property in question, but the Halls removed the cottages in late 1976 because the erosion of the protecting dunes had caused the structures to be undermined. By 1982, the beach had returned in front of the cottage sites sufficiently so that the Halls decided to rebuild. They asked the town code enforcement officer whether any state permits were required for construction of the cottage. He told them none were required, and they began construction in August, 1982. By the middle of November the cottage was 90% complete, at which time construction was halted for the winter.

In December, the Halls received a letter from the Department of Environmental Protection informing them that they must apply for a sand dune permit. The application was submitted on December 29. A follow-up geological assessment was filed April 1, 1983. On April 27, 1983 the Board denied the application. The Halls then filed an amended application, changing some specifics, such as raising the posts supporting the cottage, planting beach grass, and providing a boardwalk to the beach. On July 13, 1983, the Board denied the Halls' revised sand dune permit application at the same meeting at which the sand dune regulations had earlier been adopted (Hall v. BEP (3), 1984). This denial was based on board findings that the beach was recessional, and therefore the project would unreasonably interfere with the natural supply and movement of sand; that the house would interfere with beach grass stabilization of the dune, presenting an erosion hazard; and that the house was likely to be in a V-zone within the next 25 years and therefore constituted a flood hazard (MDEP, 1983 (Hall)).

A week later, plaintiffs petitioned the Maine Superior Court for review of the Board's order on seven counts, which included the allegation that:

> If the statute requires the decision rendered, then it deprives plaintiffs of their property, destroys its value ($60,000), and constitutes a taking of property in violation of the Maine and United States Constitutions for which the petitioners must either be awarded compensation or else granted a sand dune permit. (Hall v. BEP (3), 1984)

The petitioners lost on all counts; the Board also won its counterclaim for removal of the cottage. With regard to the "takings" claim, which figures so prominently in litigation over police power regulation--particularly in the environmental area--the court concluded as a matter of law that "two lots of ocean front property consisting of sand beach and dunes in a popular beach recreation area cannot be considered essentially useless, even in an unimproved state." (Hall v. BEP (4), 1983)

The court's findings generally followed traditional "takings" doctrine (Spiegle v. Borough of Beach Haven, 1971; Just v. Marinette County, 1972) and Maine case law (Seven Islands Land Co. v. Maine Land Use Regulation Com'n, 1982; In Re Spring Valley Development, 1983). The Maine case of State v. Johnson, on which petitioners relied heavily, was a wetlands case, where there seems to have been general acceptance by both sides that the property was valueless without the opportunity to fill and develop it. This was not proven in the Hall case, nor could it be; the value of Maine's limited beach for recreational rights cannot be considered insignificant. Indeed for several years the Halls had been parking their trailer and enjoying the rights attendant on private beach ownership in Maine In other parts of the country, it should be noted, such "beach rights" are a saleable commodity (Crichton, 1984).

The Halls have appealed this decision. It is to be hoped and expected that the Maine Supreme Court will uphold the Superior Court's decision.

A second case involving construction on a frontal dune on the same Phippsburg beach, the Rubin case, is also in litigation. The Rubin petition challenges the regulations themselves, claiming that "the absolute prohibition [of construction on a frontal dune] contained in the regulation is impermissible under the statutory authority which requires the issuance of a permit if certain standards of reasonableness are met, such determination being required to be made on the facts of each permit application." (Rubin v. BEP, 1983)

An absolute prohibition was at issue in another permit denial, this time for construction of a new seawall, sought in a joint application by four adjacent property owners on the Pine Point Beach in Scarborough, Maine. This application is often referred to as the Woodbury case, after one of the more articulate and outspoken of the seawall applicants, Carolyn Woodbury. That permit was also denied (MDEP, 1983 (Nevius et al.)), a denial that was the impetus not for litigation but for legislation.

Proposed Legislative Amendment

In the 1984 session, dissatisfied landowners decided to pursue their remedies in the legislature, as the representative from Popham Beach had promised five years earlier. On March 15, 1984, Senator Danton of the highly developed southern coastal town of York presented to the legislature "An Act to Clarify the Sand Dunes Law." The title was clearly a misnomer. As the "Statement of Fact" that accompanied the bill makes clear, the intent was to forestall or overrule adverse decisions of the Board in the Hall and Woodbury or similar cases by allowing the rebuilding and replacement of permanent structures within the sand dune system and the construction of new seawalls to protect existing structures and utilities (L.D. 2264, 1984). The bill was withdrawn, an action apparently influenced by testimony of the DEP

Commissioner that were the bill withdrawn, the agency would adopt a variance provision to provide some flexibility to the sand dune regulations.

The Variance Provision

The DEP staff prepared a draft of an amendment to grant variances from the standards of the Sand Dune Rules and submitted it to the Board in April. The Board held a public hearing on the proposal May 30, 1984, in South Portland and written comments were also submitted. None supported the variance as written.

The staff then presented the Board with four new drafts of a variance proposal, numbered options #1 - #4 and ultimately with a fifth option, outlining a fairly narrow variance. Option #5 allows variances only for buildings landward of the crest of the frontal dune and for seawalls where wave action is not the primary cause of erosion - and then only if the variance applicant meets other conditions. Thus the variance could not apply to the Hall case, but is arguably applicable to the Woodbury seawall application, depending on the cause of erosion there.

The State's marine geologist and the state coordinator for the Federal Flood Insurance Program both gave brief presentations to the Board, generally opposed to major changes in the regulations. The marine geologist also proposed that an option to a variance might be to reconsider the concept of mapping and zoning the beaches so that landowners would know, for example, exactly where the frontal dune ridge fell on their property. Such a system appears to have been contemplated by the governor's advisory committee whose recommendations led to the passage of the original sand dunes law (CCDC, 1978).

At their September 26 meeting, the Maine Board of Environmental Protection unanimously adopted the Option 5 variance provision. Neither the Commissioner of the Department of Environmental Protection nor the Board members think that this provision will stop all criticism of the sand dune law and its administration, but they feel that it is a reasonable step in what chairman Zaitlin terms an "evolutionary process." In addition, the State Geologist and his staff will be drafting language for sand dune zoning legislation to be introduced at the first session of the 112th Maine Legislature, which will convene the end of this year.

Conclusion

Maine's sand dune law and regulations have not stopped development on Maine's dunes, but they have controlled both where and what types of development occurred. The numbers of permit denials do not tell the whole story. Since the regulations came into effect only one permit for a new seawall has been denied, but only one has been applied for. The prohibition is clear, and people are simply not applying to construct new seawalls. In other cases, negotiations before Board action caused modifications in the applicants' original project proposals to conform to the regulations and allow approval. Conditions requiring that buildings be built further back on lots (out of the V-zone) and on posts, that beach grass revegetation be undertaken, and that open fencing and signs protect endangered and threatened species of seabirds have contributed to maintaining the health of Maine's dune systems and of the wildlife that depend on them, despite development.

The safety of property owners using the structures, and of their neighbors, has likewise been enhanced and the potential for property losses, diminished.

The sand dunes law is not a planning mechanism, however, but merely a control on conditions of development. The proposed mapping scheme might interject a bit more planning, but certain problems cannot be dealt with under the current system. For example, the severely limited amount of public ownership and access to Maine's coastline, particularly its beaches, needs to be addressed, as does the issue of whether certain beach areas should be preserved in a natural state, even if construction could safely occur there. Acquisition programs may be the only answer in some cases, although other innovative and less costly approaches to achieving these goals must be vigorously pursued. Federal efforts such as putting the National Flood Insurance Program on an actuarily sound basis and the Coastal Barrier Resources Act are helpful—although the latter has limited application in Maine because Maine has so few miles of undeveloped barrier beaches.

One proposal that was deleted from the original regulations, then occasionally used as a permit condition, but that is no longer applied, allowed construction or reconstruction of a dwelling only on the condition that if it were over 50% destroyed, it would not be rebuilt. Where reconstruction of storm-damaged building is allowed and it cannot be completely moved out of the V-zone, this seems like a reasonable condition. Maine has yet to have the problem that will arise sooner or later of a shoreline change that places many houses in a V-zone, or on a frontal dune, followed by destruction of those properties, in which case reconstruction should not be allowed. It remains to be seen if the law will stand and prohibitions on reconstruction be upheld in such circumstances. The opinion on appeal in the Hall case may give some clues to what might happen in the courts, but the likely legislative response is a matter of pure speculation.

Finally, as structures like the condominiums now being constructed on Old Orchard Beach proliferate, i.e., buildings engineered to withstand a hundred-year storm in areas of subsidence unprotected by frontal dunes, we are likely to face the problem of permanent structures standing in the water on submerged lands. This is a problem that is beginning to face many coastal states and that will have to be addressed.

Thus Maine's state-wide coastal sand dunes law is only a beginning, but it is a beginning that may provide a useful model to other coastal states, or perhaps to local communities, that have not taken even this first step. They may benefit from a consideration of the Maine experience in framing legislation and regulatory programs to protect their own coasts.

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Any errors in the article and all opinions expressed are those of the author.

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Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ. Copyright by The Coastal Society 1985.

COMPARISON OF THE PLANT COMMUNITY IN NATURAL AND MANAGED FOREDUNES ALONG THE ATLANTIC COAST OF NEW JERSEY

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Introduction

The importance and value of coastal foredunes have been recognized for many years by humans. Dunes protect leeward areas from storm flooding, contribute sediment to the beach sand cycle, and are unique coastal habitats (Ranwell 1972, CERC 1977). People have modified and built dunes in the hopes of improving their inherent functions. Management practices that have been incorporated into the construction and stabilization of sand dunes include the use of vegetative plantings, fertilizers, and sand fences (CERC 1977, Seneca 1980). In the course of these activities humans have been creating, disturbing, and modifying the foredune habitat.

The most common applied foredune management technique includes the use of sand fencing, vegetative plantings, and annual fertilization (CERC 1977, USDA 1978). Sand fences are placed landward of the beach to accumulate sediment. Vegetation propagules (usually _Ammophila breviligulata_) are systematically planted on the sand accumulated by the sand fences. Fertilization (slow release) is then applied to increase the growth of the new plantings, followed by subsequent annual applications of fertilizer to ensure good growth and cover. This management program is recommended by the New Jersey Soil Conservation Service.

The highly developed coast of New Jersey contains both natural and actively managed foredunes. Gares et al. (1979) referred to managed dunes as "artificial dunes" since they were created by humans. In this investigation, a "managed" foredune was defined as a foredune which had an active management program consisting of sand fencing, vegetative plantings, and annual fertilization. Managed foredunes are present in residential and developed areas. A "natural" foredune was defined as a foredune which did not receive human inputs from management practices and natural processes dominate. Natural dunes are located in federal and state parks.

The objective of the research was to examine some foredune plant communities influenced by management techniques to see whether certain management practices affected the structure and composition of the vascular plant community. Common plant species characteristics and plant community values from managed foredunes were compared with natural foredunes.

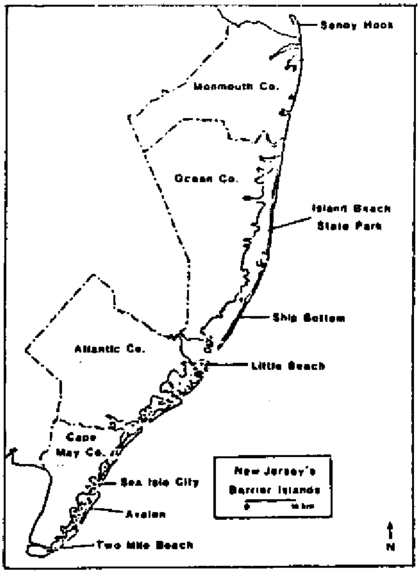

Figure 1. Location of study sites along the coast fo New Jersey.

Study Sites

Study sites were selected to represent managed and natural foredunes (Figure 1 and Table 1). Seven study areas were selected based on information from personnel at the Center for Coastal and Environmental Studies (CCES), Rutgers University, and the publications "Coastal Geomorphology of New Jersey Volume I and II" (Nordstrom et al. 1977) and "Coastal Dunes: Their Function, Delineation, and Management" (Gares et al. 1979).

Each study site had a management program for the foredune area sampled (Table 1). Little Beach, Island Beach State Park, and Sandy Hook were classified as natural foredune study sites. Sea Isle City, Avalon, Two Mile Beach, and Ship Bottom had active management programs and were classified as managed foredune study sites. Disturbances from pedestrian traffic in the foredune areas surveyed were observed at Sandy Hook and Ship Bottom. The trampling index (Table 1) was determined from the observations of footprints in the foredune area surveyed and beach usage near the study site.

Methods

At each study site a 100 m section of the foredune area parallel to the shoreline was selected to be examined. Heavily disturbed foredune areas, such as access paths, were avoided since the impacts of these paths on the foredune plant community was evident. A 100 m baseline was established parallel to the shoreline on the backshore of

Table 1. General information about the study sites. Location is the latitude/longitude of the study site. Azimuth is the compass degree heading of the transects. Management is the type of foredune management program in the study site (N=natural, F=fertilization, P=vegetation plantings, SFZZ=sand fencing-zigzag pattern, SFST=sand fencing-linear pattern). Trampling is a qualitative observation of pedestrian traffic occuring within the foredune area (0=no pedestrian traffic; 1=pedestrian traffic present).

Study Site	Location	Azimuth	Management	Trampling
1 - Little Beach	74°19'/39°27'	124	N	0
2 - Island Beach State Park	74°05'/39°49'	110	N	1
3 - Sandy Hook	73°59'/40°27'	86	N	1
4 - Ship Bottom	74°11'/39°39'	140	P/SFST/F	1
5 - Sea Isle City	74°42'/39°07'	144	P/SFZZ/F	0
6 - Avalon	74°44'/39°05'	115	P/SFST/F	0
7 - Two Mile Beach	74°52'/38°56'	144	P/SFST/F	0

the beach near the seaward toe of the foredune. Transects were chosen within the 100 m area by selecting eight random numbers and locating the numbers on the baseline. Transects ran perpendicular to the baseline bisecting the foredune area. Transects were stopped after leaving the foredune dunegrass-herbaceous community, entering the shrub or secondary dune community, or when heavily disturbed backdune areas were encountered. Topography of the foredune was recorded by calculating the relative change in elevation each meter as the quadrat was moved along the transect.

Vegetation sampling

A consecutive series of one square meter quadrats were recorded along each transect. The quadrat was divided into 25 square subquadrats (20 by 20 cm) by placing string across the quadrat frame at 20 cm intervals. The intersection of strings were used as 16 observation points to estimate cover (Greig-Smith 1964). Vegetation variables measured in each quadrat were cover, density, and local rooted frequency of the vegetation. Cover was recorded by the presence of vegetation under the string intersections. Density was the number of individuals in the quadrat. Local rooted frequency for each species was estimated by counting the number of subquadrats the species was rooted in each quadrat. Plant nomenclature follows Fernald (1950).

Data analysis

An experimental design was formulated to examine the different foredune plant communities by comparing variables of the common plant species in the seven study sites. An analysis of variance (ANOVA) was set up to investigate differences between the study sites (Zar 1974). Vegetation data was transformed according to the properties of the data as suggested by Greig-Smith (1964). Raw and transformed data for each transect was tested for normality. Both the raw and transformed data showed nonnormal properties (highly skewed). Therefore, means of the raw data for each transect were used as observations in the ANOVAs to provide a more robust test. If the study site factor in the ANOVA model was significant, a Least Significance Difference (LSD) was calculated to reveal which values were significantly higher or lower (Zar 1974). The word "significant" is used in the text to indicate a statistical significance.

Some community values were calculated to compare the composition of the foredune plant communities. The Jaccard's Coefficient of Community (CC); $CC = 2 Sab / (Sa + Sb)$ and Percentage Similarity (PS); $PS = 1 - 0.5 \sum |Pa-Pb| = \sum Min(Pa \text{ or } Pb)$ were calculated for each study site (Whittaker 1975). For the coefficient of community, Sa and Sb represent the number of species in study site A and B, respectively, while Sab is the number of species common in both communities. The coefficient of community expresses community similarity based on the presence/absence of the species. For percentage similarity, Pa and Pb represent the decimal importance of a given species in study site A and B, respectively. Importance values for percentage similarity were calculated using relative cover, relative density, and relative local frequency. Percentage similarity expresses the degree of quantitative similarity between the two communities. Little Beach was the study site used to compare all other plant communities for the coefficient of community and percentage similarity because Little Beach was considered the most natural foredune studied.

Results and Discussion

The foredunes and their associated plant communities were examined during the period from late May to July of 1983. Sand fencing changes the topography of the foredune by accumulating sand but does not stabilize the sand dune (Seneca 1980). The influence of sand fencing on the topography of the foredunes at Avalon and Sea Isle City was evident. These study sites had two distinguishable foredune profiles. A line of sand fences seaward of the vegetated foredune formed an unvegetated sand dune near the backshore of the beach. These foredune profiles indicate that with the placement of a sand fence seaward of the vegetated foredune sediment will accumulate at the seaward fence. These sand fences, therefore, decrease sediment movement from the beach into the foredune area landward of the sand fence.

Comparison of the foredune plant communities

Fertilization has been shown to significantly increase the cover and density of A. breviligulata (Hawk and Sharp 1967, Huiskes 1980). In this study, the total cover of the plant community was significant for the study site factor (F=12.6, Prob.=<0.001). Study sites which had managed foredunes had higher cover compared to the natural study sites (Figure 2). Avalon ($\bar{x}$=33.8%) and Sea Isle City ($\bar{x}$=34.9%) had significantly higher cover compared to Little Beach ($\bar{x}$=14.7%), Sandy Hook ($\bar{x}$=10.5%), and Island Beach State Park ($\bar{x}$=7.4%). The cover of A. breviligulata was also significant for the study site factor (F=11.8, Prob.=<0.001). Two groups were statistically distinguishable with certain managed foredunes (Two Mile Beach, Avalon, and Sea Isle City) having significantly higher cover than the natural foredunes (Little Beach, Island Beach State Park, and Sandy Hook)(Figure 3). Ship Bottom, classified as a managed site, was statistically grouped with the natural study sites.

Study sites which received annual fertilization (managed foredunes) had higher cover compared to the natural foredunes. Ammophila breviligulata accounted for most of the total plant cover in the foredune plant community. Fertilization appears to have increased the cover of the plant community in certain managed study sites. One managed study site, Ship Bottom, had similar cover values compared to the natural study sites. Heavy pedestrian traffic was probably the cause of the low cover values recorded at Ship Bottom (Table 1). These results indicate that fertilization of a foredune area will increase plant cover but will not increase plant cover if trampling pressure exists.

The cover of S. sempervirens was significant for the study site factor (F=6.8, Prob.=<0.001). Ship Bottom ($\bar{x}$=3.4%) and Sandy Hook ($\bar{x}$=3.2%) had significantly higher cover compared to the other study sites (Figure 4). Both of the study sites appeared to receive heavy pedestrian traffic (Table 1). Solidago sempervirens was most prominent in study sites which had low cover of A. breviligulata and trampling (pedestrian traffic disturbances) within the foredune area. These results suggest that S. sempervirens may be a good indicator of a foredune area that has heavy pedestrian disturbances.

Few studies have actually looked at many different foredunes to determine what affect management practices have on the plant communities. Van der Valk (1975) examined artificial and natural foredune plant communities in North Carolina and concluded that the planting of a non-native species (A. breviligulata) did cause a change in the structure and composition of the foredune plant community. Seneca (1980), however, stated that the non-native species will eventually "surrender dominance" to native vegetation and the foredune plant community will return to its natural state.

Plant community composition varied between study sites. Only A. breviligulata, S. sempervirens, and C. edentula were plant species present in all seven study sites. The vegetative species planted (A. breviligulata) in managed foredunes was dominant in both the natural and managed foredunes. Certain ruderal species tended to have higher mean densities in the managed foredunes compared to the natural foredunes (Table 2). This indicates that foredune management programs may increase seedling establishment of ruderal species. The number of species in the foredune plant community were significantly different (F=15.8, Prob.=<0.001). Sea Isle City ($\bar{x}$=7.4), Avalon ($\bar{x}$=6.7), and Sandy Hook ($\bar{x}$=6.3) had the highest mean number of species per transect while Little Beach ($\bar{x}$=4.5), Island Beach State Park ($\bar{x}$=3.7), Ship Bottom ($\bar{x}$=3.7), and Two Mile Beach ($\bar{x}$=3.7) had the lowest.

The foredune plant communities were compared by calculating the coefficient of community and percentage similarity values (Figure 5).

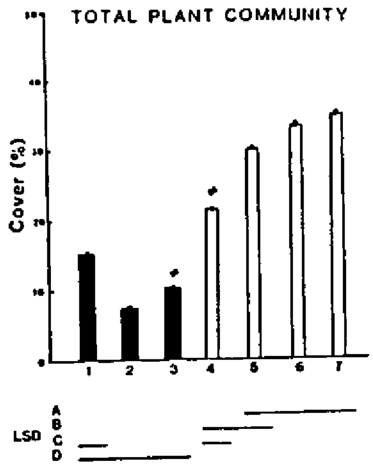

Figure 2. Mean percent cover of the total plant community. LSD is the least significant difference. Study sites (# 1-7; see Table 1) connected by the same line are not significantly different. The letters represent various groupings with 'A'as the highest values. The '#' indicates study sites which were trampled.

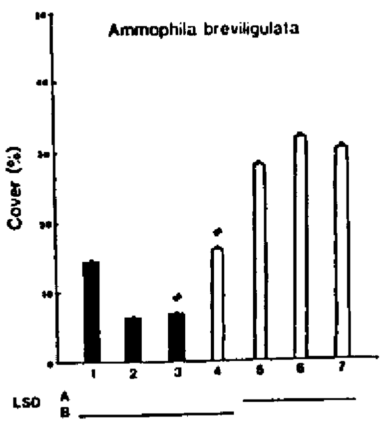

Figure 3. Percent cover of A. breviligulata. See Figure 2 for description.

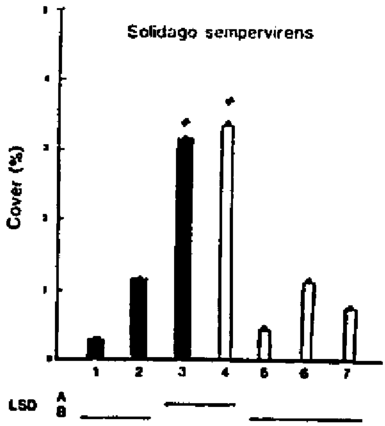

Figure 4. Percent cover of *S. sempervirens*. See Figure 2 for description.

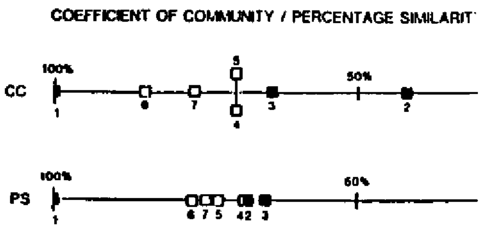

Figure 5. Plant community values expressed as a percentage distance from the study site Little Beach (1)

Table 2. Density (per square meter) of common annual plant species in the study sites.

Species	Study Sites 1	2	3	4	5	6	7
Cakile edentula	0.7	2.1	1.3	0.9	0.3	0.5	1.5
Cenchrus tribuloides	<0.1	-	<0.1	<0.1	0.4	0.4	-
Erigeron canadensis	2.1	-	-	<0.1	10.1	3.5	4.6
Euphorbia polygonifolia	<0.1	1.1	0.1	0.2	-	-	-
Gnaphalium obtusifolium	2.2	-	<0.1	-	1.0	0.3	-
Salsola kali	0.1	-	0.1	-	<0.1	0.2	<0.1
Strophostyles helvola	0.3	-	<0.1	-	0.4	0.1	<0.1
Triplasis purpurea	0.1	-	<0.1	0.3	<0.1	1.8	-
Xanthium strumarium	0.4	-	<0.1	-	0.6	<0.1	<0.1

Using Little Beach as the comparison study site, managed foredune plant communities were more similar to Little Beach than the other natural foredunes examined. Community values revealed that the managed foredunes had similar plant community composition compared to Little Beach. The other natural foredunes (Island Beach State Park and Sandy Hook) were dissimilar from Little Beach. This suggests that there was a large amount of variation in the composition of the natural foredune plant communities examined along the New Jersey coast. Managed foredune plant communities, however, showed a good deal of similarity between study sites. Management practices may decrease the variability of the composition of the plant community.

Summary

In summary, management practices and techniques (fertilization, sand fencing, and vegetative plantings) did affect the foredune plant community. The composition of the foredune plant communities of managed study sites was similar to certain natural study sites. Managed foredune plant communities, however, showed a small degree of compositional variation compared to the natural foredune plant communities examined. The planted vegetation in the managed foredunes did not affect the composition of the managed foredune plant communities since the species was dominant in natural foredunes. The structure of the managed foredune plant communities was different than the natural foredunes. Managed foredunes had significantly higher cover compared to the natural foredunes. Many annual ruderal species had larger densities in managed foredunes.

Sand fences in managed study sites affected the foredunes topography, sediment movement, and microhabitats. Sand fences seaward of the vegetated foredunes accumulated sand. Sand fences changed the microclimate of the seaward slope of certain managed foredunes by decreasing sand movement and providing protection from salt spray.

Pedestrian traffic appeared to influence certain foredune plant communities. Total plant cover was low in study sites with evidence of trampling. Solidago sempervirens had higher cover in trampled study sites suggesting that S. sempervirens may tolerate trampling better than other dune species. Driftline plant species and vegetative plantings seaward of the sand fences appeared to be destroyed from human recreation on the beaches. Sand fences also appeared to act as a barrier to pedestrian traffic in the foredune area. The seaward limits of vegetation establishment appeared to be dictated by the amount of beach usage, tracks of off-road vehicles, and sand fence placement.

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ABANDONMENT OR ADJUSTMENT: CHANGING STRATEGIES FOR THE MANAGEMENT AND CONSERVATION OF THE IRISH COASTAL DUNES

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Introduction

Politically Ireland is divided into two. Such a division is apparent in the approach to nature conservation and management (Carter 1985a) despite the obvious similarities in the resource base. However, dichotomy in policy is not matched by dichotomy in conservation practice, largely due to lack of funds and few adequately trained field staff. Although the Irish coast is probably the major tourist attraction, management is haphazard. Such a wayward approach is epitomised by the numerous techniques and tactics employed in conserving the Irish coastal sand dunes. The purpose of this short paper is to describe the changing patterns of dune management and conservation in Ireland over the last 140 years, and to compare rates of failure and success. Some conclusions are drawn as to the "distinctiveness" of the Irish dunes and the lessons appropriate to management policies and planning.

The Irish Dune Systems

The physical and biological background of the Irish dune systems has been outlined in Quinn (1977) and Carter (1985b) and only a brief resume is included here.

The Irish dunes were formed largely between 5000 and 2000 bp as the post-glacial sea-level rise slowed, halted or even reversed. The bulk of the sediment was derived from shallow shelf sands of glacigenic origin, transported and sorted by marine and eolian processes. Distribution of dune systems reflects the glacial limits. (Fig. 1). At present sediment supply, apart from reworking (particularly around estuary mouths) is decidely limited.

There are no large-scale dunes forming today.

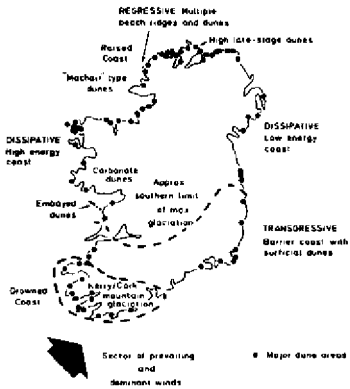

Fig. 1 Distribution of Irish dune systems

The main dune building vegetation is Ammophilia arenaria, but inland the dune ridges are well-covered with grasses and shrubs. Most dunes are base rich due to calcium carbonate influx, although in places, leaching has led to the establishment of more "acidic" species (e.g. Erica, Pteridium) on the older dunes. Intra-dune ecological gradients, due to moisture, shelter and especially grazing, have produced a complex vegetation mosaic. This natural diversity is an important key in dune management and conservation.

Early Disturbance - The Abandonment Phase

As the Irish population rose rapidly in the 1700s and 1800s so dunelands were used increasingly for agriculture. Extensive soil disturbance, mainly for potato crops, but also for cereals, flax and rabbits led to widespread sand blow. Contemporary records (e.g. Clarke 1837; 1837) voiced considerable concern about over-use of the fragile dune sails, particularly where property was threatened by engulfment. However, the main response to dune instability was abandonment, often involving the emigration of whole communities. At Magilligan in Co. Londonderry, approximately 80% of near-coast inhabitants either moved inland or overseas in the early nineteenth century.

Most of the Irish dunelands fell within large private estates. The attitude of landlords, when faced with instability varies from estate to estate. In some cases nothing was done, the unstable ground merely abandoned and the indigenous population left to fend for itself.

Elsewhere some measure of dune restoration was undertaken, perhaps in association with land reform. Murphy (1980) has collected many early records of land dune instability.

In Co. Sligo and south Co. Donegal, Clarke (1835) recorded over 500 acres (120 ha) covered by up to 3 m of loose blown sand.

In many townlands the area under tillage fell dramatically in the early nineteenth century. In Ballintemple townland, Co. Sligo, 105 acres (29 ha) were taxed as cultivated land in 1800, by 1835 this had fallen to 5 acres (1.2 ha). At Strandhill in the same county, the village was engulfed and the villagers moved inland to settle on marginal upland bog. Rosapenna in Co. Donegal (Fig. 2) suffered the same fate, 16 farms were abandonded in the early nineteenth century. Ultimately many of these vulnerable folk would have died in the famine, or emigrated. The general attitude of the peasant stock was of disbelief and despair.

Fig. 2: Lord Boyle's house - engulfed by sand in mid eighteenth century and exposed 120 years later.

Some estates, for example Lord Palmerston's at Mullaughmore, Co. Sligo and Lord Leitrim's at Rossguil, Co. Donegal undertook successful plantings of vegetation, mainly Ammophila, although at Mullaughmore shrubs and trees were established. These remedies were largely successful due to the fact that access to the land was restricted and in the case of Mullaughmore, measures were taken to exerminate and then exclude rabbits. In other examples, Ammophila plantings were none too successful, probably because the land was brought back into agricultural use too quickly.

During the late nineteenth and early twentieth centuries the Government undertook a series of land reforms in Ireland, to remove many of the existing inquitous tenure systems. These policies led to a state interest in dune management, under the aegis of the congested Districts Board (later the Irish Land Commission). The Board organised a number of small dune restoration schemes, largely by planting Ammophila. In the 1920s and 1930s, the commission undertook two major dune reclamation schemes, one on Achill Island in Co. Mayo and the other at Horn Head in Co. Donegal. The latter still remains the largest dune reclamation scheme so far attempted in Ireland. Problems arose through mismanagement of the Stewart Estate following the desertion of the land by the Stewart family after the First World War. Within 3 years of desertion overgrazing by tenanted farmers led to serious sand blow (Fig. 3) which by 1925 had turned the Dunfanaghy Estuary into a brackish lake and threatened the adjacent village. The Land Commission Scheme involved planting of Ammophila and later Pinus. Once again the land was abandoned, access restricted and recovery achieved within 10-15 years. The land has been resold for agriculture and is lightly grazed.

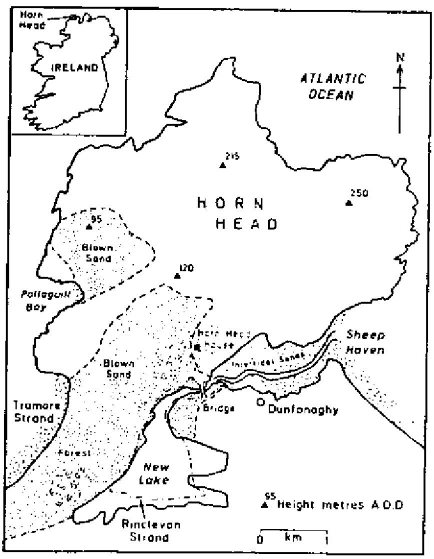

Fig. 3 The Horn Head estate - blown sand 1919-1926

The Adjustment Phases

Engineering Approaches

The advent of recreation pressure on the Irish sand dunes rapidly led to serious dune erosion problems. At Portrush, Co. Antrim local residents were complaining of blowing sand only ten years after the arrival of the railway in 1855 - and with it a huge influx of tourists and day visitors. Within 50 years many sand hills had become deruded of vegetation and significant amounts of sediment had blown inland, causing shoreline recession. The problem was overcome through construction of sea walls, often serving a dual function as promenades. Many Irish dune systems disappeared under concrete between 1890 and 1960. The consequences of these actions have largely been manifested in severe beach erosion, following the completion of a sea wall at Portrush in 1963, the beach level has dropped 1.5 m and major underpinning of the wall has been undertaken.

All too often the engineering "solution" has been applied in the absence of prior scientific appraisal, taking no account of natural compensatory beach/dune sediment exchanges. The ploy of "holding the shoreline" often spells disaster for the beach and an important recreational asset is lost. In some instances, Rosslare Strand, Co. Wexford, is the best Irish example, techniques and tactics have changed regularly with little sense of overall objective. The net result is the loss of a natural dune system, and a fresh set of problems related to the beach.

Environmental Approaches

Cost and aesethic factors, plus a general disillusionment with the efficacy of civil engineering solutions all contributed to a change in direction in the mid 1960s. Severely degraded dune lands at Brittas Bay, Co. Wicklow (Mawhinney and Quinn 1970), Murlough, Co. Down (Whatmough, 1977) and Portrush, Co. Antrim (Wilcock and Carter 1977) all underwent "environmental" restoration, employing a mixture of natural and artificial encouragements. There are several problems to contend with. One, fresh sand supply is limited, so that snow fences are of little use. Two, it is difficult to close down heavily used recreation areas to allow restoration. Three, education, both general and specific, was, and still is, at an agonisingly low level.

All the above mentioned studies tried to "zone" duneland, to permit a continuation of activity, as well as providing recovery time, for soils and vegetation. In the Brittas Bay example, this was achieved by judious siting of car parks, in the others by use of secure fencing. Only at Murlough was wardening, on a day to day basis available. This has proved to be the crucial factor. Only Murlough may be judged as successful (Whatmough 1977, Whatmough and Carter 1982 although, ironically, its very success has led to more problems as visitor numbers and demands have grown enormously in the last decade, forcing reassessment of the conservation strategy. At both the other two sites, initial success has been reinforced by the slow drift back to degradation. Vandalism and insentitive use has arrested progress and created an air of despondency among those responsible for the initial projects.

Notwithstanding such gloom, there has been an upsurge in interest in coastal dune management in Ireland, particularly to cater for a transient, uneducated visiting population. Theoretical and practical research projects have been undertaken, ranging from studies of dune vegetation to psycological analyses of dune visitors. Most of this research aims at honing dune management skills so that they can become more cost-effective and more responsive to consumer needs. Some of the major conclusions from this work relate to trafficability and accessibility (Wilcock, 1976; Young, 1977) vegetation and slope stability (Carter, 1980), patterns of foredune construction and destruction (Carter and Stone in prep).

The Irish Dune Management "Model"

It is hard to draw together something as nebulous as dune management in Ireland and call it a "model". In a politically divided country where the coast is often afforded no districtive legislative recognition (Carter, 1985a) and decision-making on coastal matters is usually arbitary (Rea 1980), there are even problems in providing a broad summary.

However, a number of lessons have been learnt. These include:

- the traditional sagacity of dune restoration and management through abandonment has largely been lost;
- natural regeneration and growth or planting of dune vegetation is best achieved by 15-20 years of access restrictions;
- many standard methods employing sand fences are inappropriate due to the almost complete natural failure of the present day sediment supply;
- constant vigilance, preferably through wardening is necessary for successful dune restoration and maintenance;
- the level of public education on dunes is still usefully low. To the public shoreline "protection" still means concrete walls;

- diversity in dune systems is a good thing some blowing sand is essential for the retention of a vigourous ecology.

Over the last 150 years all kinds of measures have been taken to conserve and manage the Irish dunes. Some have been successful, others have not. Until now no serious appraisal of why this variability exists has been made. The value of the coast in tours of the Irish tourist economy is so high that resources must be made available for research and development into management techniques, specific to the Irish dunes, rather than the current over-reliance on imported solutions.

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EARTH SCIENCE CONSERVATION AND COASTAL DEVELOPMENTS: THE BRITISH EXPERIENCE

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In Britain, the conservation of geological, geomorphological and physiographic features of national or international importance for research and education has a strong statutory basis (Duff, 1979), with the duty of selecting and conserving these sites resting with the Nature Conservancy Council (NCC) - an independent agency funded by government; the Council also has responsibility for nationally or internationally important biological sites. There is no organisational link with the Nature Conservancy in the United States. The sites selected for conservation are ranked either as National Nature Reserves (NNR) which are owned or leased by NCC or managed under agreements with the landowner, or as Sites of Special Scientific Interest (SSSI), which remain in the ownership and management control of the original landowner; occasionally the NCC enters management agreements with the owners of SSSI. At present there are about 195 National Nature Reserves and 4200 Sites of Special Scientific Interest in Britain. Not surprisingly, a considerable number of conflicts arise over the management, development and exploitation of SSSIs, and a good deal of the NCC's work is concerned with attempts to overcome or ameliorate such threats. This paper deals only with some of the problems experienced at the coast, specifically those related to coast protection works. The pressure which is felt on important coastal sites is, to a large extent, a reflection of the high population density in Britain, with over 55 million people occupying an area of only 89,000 square miles - only marginally larger than the state of Utah. The length of the British coast is 4910 miles, and about 20% of it is defended by coast protection or sea defence works of some sort.

Several principal types of coastal site are selected as earth science SSSIs, including cliffs, sand-dunes, marshes and shell-banks, tombolos, shingle beaches and forelands, rias and raised beaches. Each has its own particular types of conservation problem, often compounded by the high population density and development pressure in coastal areas. This paper concentrates on cliffs and shingle features, and in particular the threats posed to them by engineering structures designed for coast protection purposes. This threat has grown significantly over the past 35 years, largely because of the great public concern felt in Britain over the severe damage and loss of life which occurred along the east coast in 1946 and 1953, caused by a combination of major storms and surge tides in the North Sea; 300 lives were lost in the 1953 floods. Much of the damage which occurred then could be related to the fact that maintenance of coast protection works had been largely ignored during World War 2, and major failures of the structures resulted. The outcome of this was greater central government involvement in coast protection, with funding being made available to a nationwide network of Coast Protection Authorities, usually the local Borough or County Council. Works are designed and promoted by the appropriate Coast Protection Authority and, on average, 70% of the cost is met by central government, the balance coming from local taxes levied by the Borough, District or County authorities. This public funding of coast protection works means that, in theory, all parts of the British coastline are eligible for coast protection funding from a public source, increasing the pressure on vulnerable SSSIs. The total annual expenditure is, however, small with only $25 million being spent on coast protection works in England and Wales during 1982.

Features of Earth Science Importance at the Coast.

Since much of the early development of the geological sciences took place in Britain, many localities are of very long-standing importance for their geology. A large number of classic sites occur along the cliffed coastline of Britain, such as the whole Jurassic sequence seen in the cliffs of Dorset, the famous white chalk cliffs of Kent and Sussex, and the Ballantrae ophiolite sequence in Scotland. In addition, many of the defined type-sections for chronostratigraphic units recognised throughout the world occur along the British coast, for example the Kimmeridgian, Portlandian, Thanetian, Bartonian and Waltonian Stages. Some of these sections are cut in 'hard' cliffs, which are inherently stable and do not suffer from significant erosion, retreat or collapse. However, a great many nationally or internationally important geological sites occur in soft rapidly-eroding cliffs, cut in sands, clays and weak limestones, often with rates of retreat of over 3 feet per annum. Where such cliffs (which are often 150 feet or more high) occur in the proximity of residentially or, more rarely, industrially-developed land, a threat to their continued existence in a natural state frequently arises. This threat invariably involves major civil engineering works, with massive structures being installed at the cliff foot, usually combined with cliff-grading, drainage and planting. Such works usually obliterate any geological outcrops which may originally have existed.

Where major cliff stabilisation works are proposed for a geological SSSI, the Nature Conservancy Council is automatically consulted and our views sought. However, in the case of all development requiring planning permission (a licence to develop) we do not have the ultimate power to prevent the development going ahead; our responses are limited by law to merely advising the licencing authority of the likely impact of the proposals, and recommending our preferred course of action. Whilst the authority is required to take these representations into account, they are not required to accept them, and a number of very important sites have been lost as a result of our recommendations not being implemented.

There is a form of appeal to central government, where the Department of the Environment acts as an arbiter, but even in this instance there is no guarantee that the NCC representations will be upheld. Our ultimate sanction, that of compulsorily purchasing the land in question, is a politically sensitive matter, and has never been used in such circumstances. As a result of having to operate in this engineering-dominated environment, the NCC will frequently attempt to modify the proposed engineering solution, so as to achieve a balance of conservation and coast protection by mutual agreement. This is a very difficult objective to achieve and our efforts are still at an early stage, but it does appear that there is considerable potential for obtaining more satisfactory results, and we are keen to involve as many coastal scientists and engineers as possible in our researches. Two of the case histories which follow describe successful schemes of this sort on the east coast of Britain, at West Runton in Norfolk and at Bishopstone in Kent.

Those parts of the coast which are formed by geomorphological features such as sand dunes, marshes or shingle structures present different problems. Here, massive engineering structures are less of a threat but are replaced by other artificial methods of controlling and stabilising natural sedimentary processes. The third case study presented here shows how an engineering solution has been applied to Britain's best-known and largest shingle tombolo, Chesil Beach in Dorset. In many respects the installation of the engineering structures represent a defeat for the conservation movement, but we have nevertheless been able to achieve significant modification of part of the scheme.

West Runton Case History.

West Runton cliffs in Norfolk expose nationally-important sections through sands, silts, clays and tills of Pleistocene age, and prior to coast protection works being installed were receding at more than 3 feet per annum. Much of the adjacent soft coastline of Norfolk had already been defended by permeable wooden revetments placed about 65 feet seaward of the cliffs, with the seaward face of the revetment sloping at about 45^{o} and being faced with ten courses of massive planks. The effect of this low-cost form of coast-protection, which was essential on cost-benefit grounds because of the low value of the farmland above, was highly satisfactory in cutting down erosion rates almost to zero, but resulted in the previously well-exposed cliffs (whose bases were continually being scoured by the sea) becoming stabilised at the natural angle of repose of the constituent sediments. The slopes became grass-covered and all outcrop was lost.

When similar works were proposed for the West Runton cliffs the NCC began to consider how best to try and retain the excellent natural exposures of the Pleistocene sediments in the cliffs. We soon discovered that we were unlikely to be able to stop the defences from being built at all and a compromise solution, whereby limited erosion would occur in the areas of the key exposures, was investigated. We encountered considerable opposition from the engineers in the initial stages but pressure from the Department of the Environment eventually resulted in a change of attitude by them, and we were able to seek an innovative modification to the 'standard' scheme. Our objective was to reduce the rate of marine erosion to something in the order of 5-10% of its original level, thereby virtually eliminating cliff recession whilst still allowing sufficient marine scour to remove fallen material from the foot of the cliffs and prevent the gradual loss of exposure by the natural build-up of talus. There would also be the added benefit of continuing to provide material to the beach from the cliffs, rather than starving the beach and causing erosion problems downdrift. The modification which was made to the two lengths of revetment in front of the key geological sections, 300 and 630 feet long respectively, involved reducing the number of facing-plank courses from ten to four, the courses being placed at the top and bottom of the facing, and at equal spacings between.

This simplistic solution has proved to be a very effective modification. The beach levels in front of and behind the modified lengths of revetment consistently remain at a level up to 3 feet lower than levels associated with the normal lengths, and talus build-up behind the modified lengths of revetment is much less, and also is periodically removed during storms. In addition, the modified lengths show no sign of being structurally weaker than the remainder of the scheme. After installation in 1976, a monthly monitoring scheme to record beach levels in front of and behind the revetment was introduced, supplemented by daily records of wave direction and height, daily records of wind direction and strength, and quarterly beach profiling. The data is currently being analysed in depth, but interim assessment suggests that the objectives of the scheme are being met; cliff exposure in the key areas of the site remains good, eight years after the defences were installed.

Bishopstone Cliffs Case History.

This has similarities to the West Runton case, in that the cliffs consist of rapidly-eroding soft sands and clays, here of Tertiary age. The section is of national importance for both the stratigraphic sequence which is exposed (spanning the Palaeocene-Eocene boundary and including the type-section of the Thanetian Stage) and for its unique fossil floras of Palaeocene age. The exposed section shows very unstable London Clay, which slumps readily and extensively, resting upon more consolidated and partly cemented marine sands of the Oldhaven Beds; the recession rate is about 3 feet per annum, although because of the style of instability in the London Clay slips tend to occur less frequently but cover wider areas. The cliff in Oldhaven Beds is betwen 50-75 feet high and is usually sheer or nearly so; marine scour at the cliff toe keeps it fairly free of fallen sand, although slumped debris from the overlying London Clay is locally abundant.

In an 1150 foot length of the site seven houses are at risk from the receding cliff edge, with a large number of additional dwellings likely to come under threat in about 100 years time at current recession rates. Arguably, the most cost-beneficial approach would have been to buy out the seven houses and either demolish them or allow them to collapse in due course. However, the Coast Protection Authority decided that they should seek to afford the houses long-term protection, and drew up a scheme to defend the cliffs. This entailed a mass-concrete seawall at the cliff-foot, grading back the cliffs to a stable angle and installing drains on and above the graded cliff face. The effect of this would have been to totally destroy the geological value of this nationally important SSSI and NCC therefore opposed the scheme. It proved impossible to remove the threat of the defences altogether so we again sought to modify the scheme so as to make it more acceptable. We received strong support and co-operation from the engineers department of the Coast Protection Authority and found this a most encouraging reflection on their flexibility of approach. Eventually we reached agreement over a compromise scheme which will, we hope, retain adequate exposures whilst largely solving the erosion problem. There are five elements to the scheme:-

a) Graded rip-rap apron.

This structure, 27 feet wide, will be placed upon the existing beach to protect the toe of the cliff against marine erosion, and replaces the originally-proposed mass concrete seawall. It is intended to act as an energy-absorbing structure rather than a reflective structure, and will consist of large blocks of rock placed upon a semi-permeable membrane, and anchored by their own mass. The intention is that this will permit some wave run-up and provide sufficient scour to remove talus and slipped material from the cliff-toe, whilst not permitting serious and rapid cliff recession to continue.

b) London Clay retaining wall.

The London Clay above the sheer cliff face in Oldhaven Beds will be graded back to a slope of 1 in 4, behind a retaining wall to be built 30 feet back from the existing cliff edge. The retaining wall will incorporate a rubble-filled drain, and the London Clay surface between the drain and the cliff edge will slope inland towards the drain, to prevent erosion of the London Clay cliff edge; 18 inches of the clay will be left as a cap on the Oldhaven Beds, to prevent water ingress into the soft sands beneath. It will also serve to delimit the upper surface of the Oldhaven Beds and will thus be of stratigraphic importance.

c) Oldhaven Beds cliff not to be graded.

This will ensure that a good clean section through the Oldhaven Beds will remain for study and research. It will also be cleared of all debris and loose material at the time when the rip-rap apron is being installed. The coast protection authority have also agreed that any London Clay or Oldhaven Beds debris falling from the cliffs will be periodically removed by machine or manual labour. It is unclear how often this will need to be done, but the effect will be to retain a full and usable section through the whole of the Oldhaven Beds sequence.

d) Local planning code.

When the Local Plan for the area is drawn up in the near future it will include a policy preventing the building of any further cliff-top development, thereby ensuring that the geological value of the remainder of the cliff section does not come under threat in the future. This decision on the part of the planning authority is, so far, unique in Britain, and is probably the closest approach yet in Britain to a Coastal Zone Management Program.

e) Local Nature Reserve to be established.

This will specify the detailed management objectives and practice for the whole length of cliff which is of geological importance here, not just the 1150 foot length which is being defended. This again is the first time that such a step has been taken in Britain and will ensure that the cliff and cliff-top area above is managed in a way compatible with the long-term protection of the geological sections.

The integrated approach to the safeguard of this key section is a most encouraging step forward in co-operation between geological conservationists and coastal engineers, and shows what can be achieved if both sides are prepared to put aside their differences and work together to produce a realistic solution to problems of this sort.

Chesil Beach Case History.

Chesil Beach SSSI is Britain's largest and most distinctive tombolo, and is well-known to geomorphologists throughout the world. It lies on the south coast of England, where it runs for 15 miles and connects the Isle of Portland with the Dorset mainland near Bridport. The average crest height of the beach is about 45 feet above sea level and the accepted view of its formation is that it was driven onshore during the latter phases of the Pleistocene Ice Age, when sea levels were considerably lower; with the subsequent rise in sea-level and the lack of additional shingle deposits in shallow water nearby the beach has been starved of further shingle and has, in effect, become a fossil structure. The main features of significance to coastal geomorphologists are the large size of Chesil, its composition - being largely composed of flint and chert pebbles derived from relatively local sources in the Jurassic and Cretaceous - , and the fact that it shows a systematic grading in grain size, with mean size decreasing westwards, in the direction of dominant drift.

Until World War 2 the beach was largely undisturbed by man's influence, save for some limited gravel extraction and the installation of a water main at the eastern end of the beach. However, since the war the social and economic pressures on the beach have increased greatly and led to significant damage to the beach, mainly in the cause of short-term benefit for a small number of individuals. For example, gravel extraction increased greatly with the result that it has been calculated that 2% of the overall volume of the beach was removed for use in aggregates between 1930 and 1977. Other pressures have come from the building of a large oil storage depot on reclaimed land behind the beach, from the presence of a long-established residential area behind the beach where it joins the Isle of Portland, and from proposals (later withdrawn) to build a nuclear power station immediately behind the beach.

Regular monitoring of the beach has been taking place for well over 100 years and shows that the volume of the beach is gradually decreasing, being most marked at the eastern end of the feature, where it abuts the Isle of Portland. This supports the belief that Chesil is a fossil feature, now being eroded more rapidly. The NCC had, for many years, been concerned at the implications of continuing to allow gravel to be removed from the beach for aggregate production, and in 1977 eventually succeeded in convincing the planning authority that it should cease. The effect of this had, however, lowered the height of the beach crest at the Portland end of the beach, at the village of Chiswell. In December 1978 the area was struck by a 100 year event storm which caused the front of the beach to be combed down severely, and resulted in a small local breach occurring in the beach. Chiswell was flooded to a depth of several feet and there was considerable damage to buildings and property; some buildings are still derelict today. The coast protection authority acted immediately to deal with this catastrophe, and artificially rebuilt the beach with bulldozers, using shingle from undamaged parts of the backbeach area. Since this was defined as 'emergency works' there was no obligation to consult NCC over how to carry out the work with the least damage to the geomorphological interest, and we were not told of the work until it had been carried out. This was the first major interference with the beach, and caused the natural grading to be completely destroyed over a length of several hundred metres.

Then, in February 1979, the beach was struck by another freak event when an atypical long period swell, combined with high tide and a strong onshore wind, returned the shingle to the beach but again caused overtopping and lowered the beach crest height by washing shingle down into the backbeach area. Chiswell was flooded once more, and additional damage was caused. At this stage the coast protection authority decided that engineering works had to be installed here to guard against future flooding and a possible permanent breach in the beach. Consultations took place with NCC over the proposals and we sought the views of the professional geomorphical community in Britain. It became clear that there was overwhelming opposition to the idea of installing extensive engineering works at Chesil, especially since the initial proposal was for a 1 mile length of gabions to be placed along the beach crest at the eastern end of the beach. The effect of this would clearly have been to destroy the naturalness of the feature, interfere with the grading pattern and introduce exotic material to the beach when the gabion baskets were fractured. We sought a total rethink of the scheme on the part of its proposers, including a request to look again at the cost-benefit analysis of the scheme taking into account the value of the beach to science and considering the option of buying out all the threatened property. It soon became clear that we were not going to be able to prevent the works, and so as a last resort we attempted to find ways of minimising their impact. We succeeded in having the length of the gabion run reduced from 1 mile to 490 feet, and it is now defined by the engineers as an 'experimental length'. The gabions take the form of broad gabion baskets placed on the beach crest, with three gabion courses tied together. The form of the mattresses follows the contours of the beach crest, and they are anchored into the beach at the front and back; the fill is mainly shingle which was removed from the beach more or less in situ, although part of the 'experiment' involved the use of exotic material-principally Upper Jurassic cherty limestone. The durability and survival of this material is being monitored to see how it performs relative to the natural beach deposits. The other element of the experiment concerns the construction of the gabion baskets, some of which are galvanised wire and others of which are PVC-coated wire; again, their performance is being monitored. The intention is that the mattresses should act as a flexible structure which is much better able to absorb wave energy in times of adverse weather conditions.

There is no doubt that the erosion of Chesil Beach can be reduced very greatly in this way, and that property in Chiswell can be protected, but the question which must be asked is whether the great financial and environmental cost of the engineering works can be justified for what is clearly only a relatively short-term solution? As yet, environmental factors are very rarely used in cost-benefit analysis in Britain and until their inclusion becomes automatic problems of this sort will continue to arise. The scientific integrity of Chesil Beach has, without a doubt, been severely affected by these works although at first glance the beach may not seem to have been changed in any obvious way. The extension of these works for the full 1 mile originally proposed would be a much greater threat, and it is to be hoped that the scope of cost-benefit analysis will have been significantly broadened before such an application arises.

The Principal Problems affecting Coastal Conservation.

The threats and problems which arise at coastal SSSIs fall into a number of clearly defined groupings:

a) Fragmented responsibility.

There are 121 separate coast protection authorities in Britain, without any system of formal co-operation between them. This frequently results in different levels of protection in adjacent areas, with large amounts of terminal scour often occurring at their boundaries. Sediment starvation often occurs downdrift as a result of massive terminal groynes or strongpoints being installed to trap sediment within one authorities beach area.

b) The funding mechanism.

Although the bulk of the works are funded by central government, thereby encouraging authorities to promote works, the ruling policy is that only capital works are funded and that maintenance works are not eligible for grant-aid. This means that beach feeding and nourishment is extremely rare in Britain, only three schemes ever having been undertaken. This is unfortunate from an earth science conservation viewpoint, since we believe that an effective beach would be less damaging to our sites than would structural works.

c) Overkill.

The majority of coastal engineering structures are designed with a large amount of overkill built in with the result that there is rarely any chance of cliff exposures remaining visible once the works have been built. If the design of structures was looked at in a more liberal way then it should be possible to design and install structures which would combine the needs of both coast protection and geological conservation, as has been successfully done at West Runton. We hope to see a more innovative approach to coastal engineering develop in the future, with the Bishopstone example being a major breakthrough.

d) Public attitudes.

The overwhelming public feeling in Britain at present appears to be that coastal erosion should be controlled at almost any cost, with the presence of buildings and property being an over-riding factor; conservation, environmental, landscape or aesthetic considerations are of virtually no significance. Until this attitude changes, and in view of the small size of Britain and the high density of population and development which exists this seems a long way off, there is little likelihood of major improvement in the ease with which long term conservation of geological sites is achieved. Also, there is too little consideration of environmental factors in the training of most engineers, causing another unnecessary hurdle to overcome; I hope that this will change.

e) Cost-benefit analysis.

Although each application for central government funds must include an assessment of the cost-benefit of the scheme, the analyses are deficient in that they do not include consideration of environmental and conservation issues. This inevitably has implications for public attitudes and the degree of overkill which is built into most schemes. The real difficulty, however, lies in the way in which conservation issues should be treated and quantified, prompting the leading British workers in this field to state that "if the community is willing to invest to protect its valued property in the form of houses and factories, it is no less appropriate to invest to protect valued conservation areas. The problem remaining is the valuation of such areas and, as yet, we have not investigated such a methodological and conceptual minefield".

Conclusions.

Greater co-operation and mutual understanding between coastal engineers and conservationists is likely to be beneficial to both. There have already been a number of instances where successful results have been obtained, notably in low cost engineering solutions where cost benefit is close to marginal. I believe that there is great potential for further improvement, and that this would be made more achievable in two ways. Firstly, if the central government funding agency were to exhort engineers to have greater regard to SSSIs and NNRs; to insist that environmental and conservation issues were included in cost benefit analyses; to insist that coast protection authorities co-ordinated their efforts so as to take into account the whole coastal unit of which their authority was a part, instead of acting independently; and to urge engineers to be more innovative and to investigate the possibility of using low-cost methods more frequently.

Secondly, a major public relations initiative needs to be taken by the whole geological, geomorphological and coastal science community, in order to make the layman much more aware of the social and economic significance of the coastal and earth sciences. The aim should be to make citizens more aware of all the issues involved, and to appreciate that several alternative solutions may exist. Wider public acceptance of lower-cost structures such as permeable revetments, offshore breakwaters and the wider use of beach feeding, instead of using the traditional and 'reassuring' mass concrete structures would also be likely to give better conservation results.

We are still learning how best to tackle the integration of coastal engineering and conservation and are keen to involve as many workers in both fields as we can. This paper sets out some of the ways in which we have been attempting to resolve the problem in Britain, and I hope very much that it will stimulate wider debate in Britain and in the United States. I will be delighted to hear from anyone who wishes to continue the debate, or who can supply me with information which may help us to move forward.

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Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ. Copyright by The Coastal Society 1985.

BEACH AND DUNE MANAGEMENT IN BALDWIN COUNTY, ALABAMA

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I. BACKGROUND

Coastal development is a high stakes issue for all segments of the public. High property values require developers to maximize the use of space, and setting projects back from the Gulf of Mexico affects project economics. On the other hand, many people are concerned with resource protection, public access, and other factors of development. Because today's decisions have long range ramifications for the character of the coastal area, coastal development tends to become a passionate and highly visible process.

Some would point to developers as the bad guys in the process, but this is too simplistic. The basic fact is that, if the public did not create a demand for waterfront development, development interests would be working on different projects. Our approach to coastal regulation, therefore, must recognize the rights of individuals and the public by trying to weave a concensus from the threads of the diverse and valid interests which are représented in the development and review process.

Alabama's response to beachfront development has been, thus far, a policy of recognizing the interest of the people to use the beautiful and fragile resources of the coast for recreational activities while establishing controls which will eliminate the major abuses of the development process and protect important natural resources. This is an evolutionary process and has yielded some successes and some disappointments.

Prior to the implementation of the Alabama Coastal Area Management Program (ACAMP), there were no restrictions in the location of structures on the beach and dune system in Alabama. As a result, there were several structures in the Town of Gulf Shores which were undermined on a regular basis during periods of heavy seas.

In addition, there were no restrictions on vehicles operating on beaches and dunes, and it was common practice for people to drive up and down the beach and dune systems in dune buggies, jeeps, and other 4-wheel drive vehicles. These actions resulted in significant damage to the dune systems along Alabama's beaches.

This paper will describe the general framework, the goals, and the policies of the beach and dune management system developed to respond to coastal development issues along the 22 miles of Baldwin County beaches.

II. ALABAMA'S BEACH AND DUNE PROTECTION PROGRAM

Since its inception in 1979, the Alabama Coastal Area Management Program has been concerned with the management and protection of Alabama's beach and dune systems. From the early stages of program development, there has been a recognition that beach and dune management is a synthesis of the actions of a variety of programs carried out by federal, state, and local governments.

Some of these programs are controlled directly by the Alabama Coastal Area Management Program while others are controlled by other agencies. For instance, the Federal Flood Insurance Program, administered in Baldwin County by the Building Inspector, is a vital aspect of beach and dune management, and it has important ramifications for developments on the beach and dune systems and for the beach and dune systems themselves.

The actions of these various agencies combine to provide the operating environment for development along Baldwin County's beaches and shores, and they also provide the framework for the protection of the valuable natural resources of the Baldwin County coastal area.

In order to understand the operation of Alabama's beach and dune program, it is necessary to consider several of the major goals which provide the basis for the regulatory policies and enforcement mechanisms of the ACAMP.

1. Prevent storm damage to properties.

Residents of Alabama's coastal area are well aware of the power and fury of hurricanes as they strike the beach and dune area. In 1979, Hurricane Frederick came ashore in Baldwin County causing the largest monetary loss from storm damage in U.S. history - well over $1 billion. Over 60% of Baldwin County's beachfront structures were damaged or destroyed as foundations were undermined and interiors gutted by the combined forces of wind and wave action. The beach and dune management system is designed to enhance storm protection efforts on the part of individuals and by the agencies.

2. Protect sand dunes to perform their natural functions.

Sand dunes provide a natural reservoir of sand to satisfy the energy demands of storm events as well as the natural winter/summer shoreline changes (beach profile) which occur as sands migrate offshore to form bars in the winter and migrate shoreward in the summer season. The Coastal Management Program is designed to encourage the maintenance and enhancement of the sand reservoir capacity of the beach and dune system.

3. Reduce the impact of erosion on beachfront structures.

Alabama's erosional loss in gulf front areas is estimated to be less than one foot per year. By adopting the 40 foot setback behind the crestline of the primary dune system, it is anticipated that this will provide a reasonable buffer against long term erosion loss.

4. Protect the aesthetics of the beach and dune system.

Although it is not conceived as an architectural review board, the Coastal Area Management Program has developed several policies which affect the appearance of the beaches, including a prohibition against the deposition of red clay and other foreign materials on Alabama's beaches.

5. Wildlife habitat protection.

The issue of critical wildlife habitat areas has been recognized since the inception of the Coastal Area Management Program and several policies have been adopted to insure that necessary protections are afforded the wildlife of the area.

Figure 1 provides a summary of the goals of the Alabama Coastal Area Management Program, the major policies that have been adopted in implementing the Management Program, and the enforcement mechanisms that have been adopted to ensure the compliance with these policies.

III. PROGRAM STRUCTURE

The Alabama Department of Environmental Management (ADEM) has entered into a contract with the Baldwin County Commission under which the Baldwin County Coastal Area Program (BCCAP) performs the bulk of the field and inspection work related to the program: permit application reviews, project inspections for compliance with the beach and dune regulations, permit recommendations for new projects, and monitoring coastal development to ensure compliance with the Management Program.

Carrying out these activities at the local level has provided several benefits to the Management Program. Because the BCCAP is located in the coastal area, there is increased public access to information concerning proposed projects. The proximity of the staff to these projects also facilitates the review and the monitoring of activities for compliance with the Management Program.

Another aspect of the current effort which deserves mention is the extensive public participation program established by the Baldwin County Coastal Program to stimulate public involvement in the permit decision process. Public notices are routinely published in local newspapers and individuals expressing interest in beach and dune management are provided with individual public notices for each project undertaken on the beach and dune system.

The BCCAP has also initiated a policy of conducting on-site public meetings to provide an opportunity for the public to visually assess the impact of the proposed project on the beach and dune system. Although these projects provide extensive notice and improved opportunity for public comment, the actual response by the public has been less than anticipated.

IV. MONITORING

Under the contract with ADEM, the Baldwin County Commission has

GOAL	POLICY	ENFORCEMENT MECHANISM
1. Prevent storm damage.	To raise structures above storm surge.	Flood insurance program.
	Sink pilings deep enough to withstand erosion.	High hazard building code.
	Tie structures together to withstand wind forces.	High hazard building code.
2. Protect sand dunes.	Minimize vehicle traffic on dunes.	Beach patrol.
	Minimize pedestrian traffic on dunes through dune crosswalks and architectural design.	Coastal permit.
	Coastal construction setback line located 40 feet behind primary dune system.	Coastal permit.
	Construction of a setback fence to provide access to the dunes during construction.	Coastal permit.
	Prohibit the removal of beach and dune sands.	Coastal permit and beach patrol.
	Requirement for dune enhancement programs by property owner including putting up sand fences, planting vegetation and fertilizing.	Coastal permit.
3. Reduce impact of erosion.	To construct 40 feet behind the primary dune system.	Coastal permit.
	Dune enhancement program.	Coastal permit.

4. To protect the aesthetics of the beach and dune system.	Prohibition against bringing red clay onto the beach.	Coastal permit.
	Coastal construction setback line located 40 feet behind primary dune system.	Coastal permit.
	Implementation of dune enhancement program.	Coastal permit.
5. Wildlife habitat protection.	To send copies of construction projects to the Fish & Wildlife Service for review.	Coastal permit.

established an extensive monitoring program to review activities on Baldwin County's beaches and dunes. Each project that is permitted receives several inspections during the construction period to ensure compliance with permit conditions. In addition, the Baldwin County Sheriff's Department conducts a daily patrol of the entire beachfront area to identify any projects that may be in violation of beach and dune regulations and to enforce the regulations of vehicles on the beach and dune system. This has been extremely effective in eliminating vehicles on the beaches and dunes and in the early identification of violations.

V. PROGRAM BENEFITS

The structure for implementing the beach and dune management system in Alabama has been improved on a continuous basis over the past several years, and we feel that it presently provides an excellent basis for reviewing and monitoring projects on Alabama's beaches for consistency with the Alabama Coastal Area Management Program. Some of the major results of the program so far are:

1. Most projects are located 30 to 60 feet further inland than originally requested.

2. Virtual elimination of all vehicular traffic on Alabama's beaches and dunes.

3. Establishment of a continuous and efficient monitoring system to detect violations of the Management Program in a timely manner.

4. A commitment on the part of property owners to enhance the beaches and dunes through the placement of sand fencing and the planting of beach and dune vegetation.

5. A heightened awareness of the importance of beaches and dunes to the coastal environment.

6. Elimination of red clay from the beaches and dunes of Baldwin County.

7. Minimization of pedestrian traffic on the dune systems at new projects.

8. Adoption of High Hazard Building Code to improve construction techniques.

VI. AREAS OF IMPROVEMENT

Along with the success that has been achieved by the Alabama Coastal Area Management Program in developing an effective beach and dune management effort, there are several areas which can be strengthened.

1. Determination of the coastal setback line. During three years of implementing beach and dune regulations, each project has been evaluated on a case by case basis to determine the setback to be provided for each applicant. While the majority of the decisions have been consistent one to the other, there are situations which arise which introduce uncertainty into the process.

The Alabama Department of Environmental Management is proposing the adoption of a fixed coastal construction control line from one end of the county to the other which would establish with certainty the location of the setback line for each parcel of land. This effort will be an important step in providing both developers and environmentalists with a fixed setback for each parcel and the knowledge that there will be no change in the setback unless there are significant changes in the technical information available or in erosion characteristics of the beach and dune system.

2. Lack of zoning control. Many of the comments received in connection with beachfront projects are directly related to land use and zoning implications of the project rather than to the impact on the beach and dune system. The Coastal Area Management Program does not have the capability to regulate the zoning aspects of projects along the beachfront.

The Baldwin County Commission also has not had zoning authority in the county. However, a recent legal opinion indicates that the Baldwin County Commission has the authority to adopt zoning regulations within the flood prone areas of the county. As a result, the county has recently moved to develop a zoning ordinance for the flood prone area along Baldwin County's beachfront. This is expected to provide the county with a basis for addressing some of the other issues that are frequently raised by residents.

3. Insufficient technical data. Data concerning erosion potential for Baldwin County's coastline has been very limited in the past. Although we have some historical information concerning large scale historical shoreline movement, migration trends of passes and islands, there is little information available to accurately represent erosion trends. It is anticipated that additional erosion studies will be undertaken to determine long term erosion changes. These efforts are expected to be through the use of aerial photography and beach profile measurements.

Another area of interest is in current methods to enhance and protect the dunes along the beachfront. While policies have been adopted to require the maintenance and enhancement of dunes, adequate technical information is not available to be certain what type of results can be expected from these efforts. For instance, by placing sand fencing along the beaches, what type of accretion rate can we expect on a yearly basis? What is the optimum plant mix and plant spacing for dune establishment and dune planting? Should we, for example, plant all sea oats or a combination of sea oats and dune panic grass, or should we be looking at other plants to provide cover for initial and long term stabilization?

VII. SUMMARY

The creators of the Alabama Coastal Area Management Program anticipated significant development along Alabama's beaches for second home and condominium development, and they have not been disappointed. Baldwin County's 22 miles of Gulf of Mexico beachfront, covering approximately 5,000 acres of land, has been growing rapidly since 1980. During that period of time, approximately 16% of the land has been developed into condominiums and multi-family structures. This rapid increase in development has raised the level of concern for coastal issues on the part of Alabama citizens, and it has focused increased attention on the beach and dune systems in the coastal area.

During this period, the original rules and regulations for the management of the beach and dune systems in Alabama have been buttressed through the development of enhanced permit requirements as new information and techniques have become available. Improvements have also been made in the early detection of program violations. We are encouraged by the progress that has been made. But, we must also be prepared to take new steps to continue this improvement if we are to achieve the long term goals of the program.

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WELLS HARBOR: BEACH EROSION, SEDIMENTATION, AND MEDIATION

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The town of Wells is a small community on the southeastern coast of Maine, located roughly equidistant from Portland, Maine, and Portsmouth, New Hampshire. One would not have imagined this small town as a likely location for a lengthy, bitter dispute over the management of coastal resources.

Though Wells is small when measured in terms of permanent population (roughly 9,000 in 1980), its summer population is estimated in excess of 45,000. Like many small communities on the southern Maine shore, it has become a magnet for tourists and summer residents with a strong interest in water-based recreation.

Wells Harbor is located at the mouth of the Webhannet River, a short tidal river lying behind a low barrier beach. Its outlet is a natural cut between Wells Beach to the south and Drakes Island to the north. The harbor has served recreational craft -- important to Well's tourism economy -- and a limited number of commercial lobstering vessels.

In 1960 the Federal River and Harbor Act authorized the U. S. Army Corps of Engineers to construct a project at Wells Harbor. The project was designed to: (1) reduce shoaling in the harbor, (2) fix the position and maintain the depth of the entrance channel, and (3) provide shelter from ocean waves passing through the inlet and moored in the anchorage. The project seemed simple. It consisted of building two jetties (the northern 640', the southern 940') and dredging the 100' wide channel and the small anchorage to which it led.

Problems appeared immediately. Very rapid shoaling occurred as sand was swept into the channel and harbor. Concurrently, there was severe erosion of that portion of Wells Beach near the new jetty.

Over the next three years, the Corps prepared two design supplements. Their implementation, however, was complicated by bad weather, continued rapid shoaling, and poor performance by a succession of contractors.

The Corps undertook additional studies during the mid-to-late 1970's, and in September, 1980, published an Operation and Maintenance Reconnaissance Report for Wells Harbor. The findings were sobering: the anchorage was shoaling much faster than had been expected (20,000 cu.yds./yr. vice 4,000 cu.yds./yr.) resulting in a reduction of moorings from 186 in 1974 to 40 in 1980; wave conditions in the channel were rougher than had been expected; more sand was impounded behind the jetties than had been anticipated; and beachfront property owners were contending that erosion of the Wells and Drakes Island Beaches was caused chiefly, or even entirely, by the jetties.

The social/political dynamics in Wells posed an equally thorny problem for the Corps. Town officials and many of the permanent residents viewed the maintenance dredging of the harbor as an important economic development issue. In contrast, the beachfront property owners held quite different ideas about the costs and benefits of the project. Though most of them are non-residents, and therefore non-voters in local elections, they had managed to block the dredging of the harbor, demanding an analysis of sediment movement patterns and the design of protective measures for the beaches. Tensions from other resident/non-resident interactions over the years heightened the acrimony over the long-delayed dredging of the harbor. It appeared that the only thing on which the Town and the beachfront property owners could agree was that the Corps' performance to date had been incompetent. That perceived incompetence created such a credibility problem for the Corps, especially for the beach owners, that any studies or proposals prepared by or for the Corps were regarded with mistrust verging on paranoia. Thus, proposals to dredge the harbor and place sand on the eroding beaches were rejected by the beach owners who refused to allow disposal on the beach within their property lines.

In its 1980 Reconnaissance Report, the Corps correctly concluded that "...the whole Wells community, including the disenfranchised beachfront property owners, must decide how the coastal resources at Wells are to be used." To that end, a committee of the relevant interest groups was formed, and the assistance of a mediator was sought.

The mediator selected was Susan Carnduff of the New England Environmental Mediation Center, a new not-for-profit dispute resolution organization in Boston. Assisting Carnduff was Norman Dale, a doctoral student at the Massachusetts Institute of Technology.

A few general comments about mediation are in order here, particularly to clarify what it is, and what it isn't. It isn't arbitration, that being a process in which the power for rendering a decision is vested in a neutral party much the way decision-making powers are vested in judges.

In contrast, mediation is a special type of negotiation. It is a voluntary process in which an impartial person helps parties to a dispute negotiate a mutually acceptable agreement which resolves their differences. The voluntary nature of mediation allows each party to evaluate, periodically, whether continuing to negotiate is in its best interests. If one of the parties so chooses, it can disengage from negotiations and effectively terminate the mediation. The impartiality of the mediator means simply that he/she has no stake in the outcome of the dispute, and behaves even-handedly toward all parties in a dispute. Impartiality is a characteristic of mediation which distinguishes it from negotiations assisted by a regulatory body which has jurisdiction in the matter in dispute. Finally, the mutual acceptability of an agreement reinforces the reality that the outcome of the dispute is in the hands of the disputants themselves. Only when each of them decides that the draft agreement they have negotiated is in their best interests do they sign the agreement, signifying their willingness to abide by its terms.

What does a mediator do in a situation like Wells Harbor? There are a variety of functions, and although they are discussed discretely and sequentially below, the reality is rarely that simple and straightforward.

One of the first tasks for a mediator is to decide who the relevant parties are. This is rarely as clearcut as it sounds. While gathering factual information about the dispute, the mediator probes to learn what individuals and/or organizations have a stake in the outcome. The success of a mediation depends on the "right" parties being at the table. If, for instance, a key stakeholder was not involved, it may be able to block implementation of an agreement reached by others. If, on the other hand, an organization would like to be involved in the negotiations, but is not regarded by the key parties as legitimate or having any power, its participation is likely to be resisted. As in most matters, the mediator's role in the identification of potential parties is to question, suggest, and advise. Ultimately, it is the key parties themselves who decide.

At Wells Harbor, it was clear that the Town and the beachfront property owners should be involved. Should the Corps be part of the negotiations? What about State agencies with jurisdiction in the project? What role should the process provide for the Maine Audubon Society or for Congressman Emery's staff, both of whom had pushed the idea of mediated negotiations?

After consultation with these potential parties, the mediator suggested a process in which the Town and two beach associations would be the major parties. The Corps would be available to the parties for technical assistance and for reactions to proposals. The other organizations chose not to be active participants but did express a desire to be kept apprised of the group's progress.

Another function of the mediator is to assist in the formation of negotiating teams. Who should represent the Town? In part because of their official capacity as elected or appointed officials, and in part because of their diverse interests and expertise, a Selectman, a member of the Harbor Redevelopment Committee, and the Harbor Master were chosen. The Webhannet Beaches Association was represented by its President and Vice President; the Drakes Island Improvement Association by its attorney, himself a property owner on the beach.

Near the outset of negotiations, the mediator helps the parties define the issues, however broadly, which will be the focus of their negotiations. In the case of Wells Harbor, it was important for both parties to know that in exchange for the willingness of the beach associations to discuss dredging of the harbor, the Town was willing to discuss protection and/or restoration of the beaches.

Another activity for the mediator early in the process is to suggest groundrules for the future negotiations. Typically, these are modified from case to case to meet the needs of individual parties and the context for the negotiations. Thus, the groundrules themselves become the subject of early negotiations between or among the parties. Often the groundrules will include provisions for making decisions, for convening and chairing meetings, for handling confidential information, for governing relations with the media, and for terminating the process if agreement cannot be reached. These groundrules, when mutually agreed to by the parties, provide important procedural safeguards to the parties. Anyone who has been burned in negotiations because groundrules were not articulated, understood, and agreed to can testify as to the importance of this procedural step. It also has the psychological benefit of giving the parties some experience in negotiating with one another over matters that are less inflammatory than those at the heart of their dispute.

When additional information or expertise is deemed essential before a decision can be made, the mediator can help the parties work out strategies for obtaining it in a way that maximizes its usefulness and its credibility. Sometimes the call for more information is unrealistic; sometimes it is a poorly-veiled excuse for inaction. In other instances, however, the parties may agree that certain information should be gathered to enable a better-informed decision. The Wells Harbor negotiators found a need both for additional expertise and additional data/analysis. Carnduff and Dale identified a number of persons knowledgeable in sediment transport, allowing the parties to select the one whose credentials they found most appealing. As is discussed further below, the parties also agreed that certain specific data would be obtained and analyzed before the later phases of an implementation plan would be undertaken.

A crucial function played by the mediator is to help parties develop multiple options for dealing with the problem at hand. The mediator initially probes the underlying interests of the parties, both to understand why each party has taken the particular position it has, and to broaden the array of options which would satisfy those interests (Fisher, Ury, 1981). Usually the clarification of individual parties' interests and the brainstorming of options is done in caucus with one group at a time rather than in joint meetings of all the parties. In the comparatively safe setting of a caucus, the negotiating team can test ideas in a problem-solving mode, free of the fear that their adversary might exploit a perceived opportunity.

Carnduff and Dale were authorized to caucus with individual parties. These meetings serve a variety of purposes. The mediator elicits reactions to the most recent events (usually the last negotiating session) and clarifies any apparent misunderstandings. Sometimes he/she has been authorized by another party to convey information which will be presented in the next joint meeting. These messages give other parties the opportunity to (1) blow off steam in the privacy of the caucus without jeopardizing the working relationship they are building with their adversary; (2) formulate one or more possible responses, perhaps in the form of counter-proposals; and (3) explore with the mediator ways in which that message can be presented which will maximize its chances of being accepted by the other side.

The parties are thus well prepared for the joint negotiating session which usually follows a round of caucuses. As one would expect, the mediator chairs the joint sessions, occasionally taking specific actions to improve the clarity of communications and to enhance opportunities for developing areas of agreement. One of these actions is the preparation of a so-called "single text" which provides the focus for negotiations once broad areas of tentative agreements have emerged from the discussions. With the authorship of the single text being neither their own nor their adversary's, parties are free to tell the mediator, and one another, what is wrong with it.

What were the results of the Wells Harbor mediation? The local groups met with Carnduff and Dale off and on over a period of eighteen months. During that time, they developed an Agreement in Principle and an Agreement on Conditions, the latter being a much more specific document stating conditions which the local parties felt should be followed by the Corps in the conduct of the proposed work.

In essence, the agreements linked together four areas of proposed activity: dredging the harbor, refurbishment of the beaches, collection of certain data, and the possibility of structural modifications to the jetties. While they were yet in draft form, the agreements were explained to various groups in the community to make certain that they were generally supportive. The agreements were then signed by the authorized representatives.

The Corps had previously made known to the local parties its willingness to develop a plan of action that was as responsive as possible to an agreement which the local groups might reach. With the local agreements having been executed, the Corps developed such a plan. In brief, it was a phased plan with certain major actions contingent on a satisfactory outcome of one or more of the initial actions. First was initial data collection (directional wave data collection, sediment sample collection and analysis, and evaluation of sediment movement mechanisms). Second was initial beach refurbishment, using sand which had accumulated in the fillet areas next to the jetties. Third was to begin the dredging program, including renourishment of the eroded beaches with suitable material from the dredging. Fourth was a joint evaluation of the three previous actions, the results of which might fundamentally change the fifth and sixth phases: full implementation of harbor dredging and beach refurbishment, and selection and implementation of structural modifications.

However, reaching agreement among the local groups, and the preparation of a compatible plan were not sufficient to guarantee successful implementation. Beach refurbishment and dredging activities (steps 2 and 3) have been delayed by an impasse over temporary easements necessary to lay the pipeline across individual plots of beach property. Those negotiations have occurred sporadically over a two-year period, for the most part without mediator assistance because of cost considerations. The parties still believe, however, that the agreements they jointly developed represent a desirable resolution of their differences.

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THE CALIFORNIA STATE COASTAL CONSERVANCY AND CONFLICT RESOLUTION: RECONCILING COMPETING INTERESTS FOR LAND USE IN THE BOLSA CHICA WETLANDS.

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I. INTRODUCTION

Decisions regarding the use of land are becoming more important to our society as well as to each individual. There was a time when the problems associated with urbanization and development could be solved (at the individual level) by simply moving to new, as yet undeveloped parts of the country. In the past, America operated on the assumption that there would always be plenty of open space and one more frontier to settle. But land, like many of our other natural resources, is becoming scarce, and man's power to effect large-scale changes in his world is increasing. Any approaches to making land-use decisions must acknowledge this new state of affairs.

Following World War II, individual land-use decisions began to affect a greater portion of American society. During the 1960's ahd 1970's, State and Federal governments created regulatory schemes to cope with the relatively new problems caused by unrestrained development policies. New single purpose agencies were formed, stricter procedural standards were promulgated, and in effect, any major land development project had to be enjoy broad support among the affected parties, or it could be vetoed. The assumption that private sector concerns would be the primary standard for development policies no longer held true. Economic considerations became part of a complex criteria for assessing a development scheme which now included social concerns as well.

The State of California was particularly aggressive in implementing land-use regulations, especially in areas where development could have a detrimental effect on the surrounding habitat. Because there is so much valuable coastal property in the state, one of the areas to be most heavily regulated was the so-called "coastal zone." In 1972, the citizens of California passed an initiative creating the California Coastal Act, which placed considerable limits on the amount and kind of development that could take place in the coastal zone, and which created a regulatory agency, the California Coastal Commission, to interpret and enforce the Coastal Act Standards and to prepare a plan which was ultimatly to become the California Coastal Act of 1976.

Like many regulatory agencies, the Coastal Commission tended to be as vigorous in pursuing non-private sector interests as past institutions hads been in supporting private development. Often, the Commission's ruling placed a different burden on private developers by requiring such strict adherence to every element of the Coastal Act provisions that it was virtually impossible for many developers to realize any reasonable return on their investment in coastal property. As a consequence, many development and restoration plans were tied up for years in litigation by those who felt that, given the seemingly adversarial stance of the Commission, there was little to be lost by fighting for everything they could get.

I was legal counsel for the Commission at the time between 1973 and 1975 when they were creating the Coastal Plan. I also authored the Management portions of the Plan that I later translated into the Coastal Act that the legislature passed. At that time I recognized this problem and recommended the creation of a novel agency,the Coastal,Conservancy,to attempt to deal with some of the inadequacies of Regulation. The legislature agreed and in 1976 established the State Coastal Conservancy.

The creation of the California State Coastal Conservancy was a response to this troublesome situation. One of the Conservancy's primary goals is to expedite the development process in coastal land-use proposals while still meeting the provisions of the Coastal Act. The Conservancy uses a number of mechanisms to achieve this goal. At the request of State agencies, local governments, non-profit organizations, and private business, the Conservancy mangages and grants funds for projects to enhance, restore, and preserve coastal resources as a part of proposed land-use plans. Additionally, the Conservancy will often assume the role of lead agency, developing, implementing and funding plans in accordance with the Coastal Act where such development is economically unfeasible for these other parties.

In many cases it is undesirable or unnecessary for the Conservancy to directly assume responsibility for a particular project. In these instances, where there is a dispute over the best way to develop a particular area, or where the parties involved have been unable to create a plan which meets the terms of the Coastal Act and still provides a return on their investment in the area, the Conservancy acts as a mediator in the conflict, designing proposals which accommodate the interests of all the parties involved in the dispute. It is this aspect of the Conservancy's responsibilities which make it unique.

The Conservancy operates under unique constraints in its capacity as a mediating agency. When state land or Coastal Act regulations are not an important element in the dispute, then the Conservancy acts as an unbiased, impartial arbitrator, a function critical, though generally lacking in these disputes. Conversely, when State property or regulations <u>are</u> part of the dispute, the Conservancy must both advance the State's interests and act as a mediator, a difficult and delicate task at best. This dichotomy is a function of the fact that the State's primary interest is in seeing these disputes resolved, rather than ignored. If too many disputes remain unresolved, the end product of the agency's work is unresolved conflicts, which in practical terms means that all the parties involved in the conflict lose in the end.

In order to achieve this difficult mediating goal, the Conservancy has had to develop rigorous and ofter innovative approaches to resolving land-use disputes. The purpose of this report is to describe the principles which underpin the Conservancy's technique and resolving these disputes, and demonstrate how they have been applied in Conservancy efforts to mediate conflicts throughout the State by focusing on a particularly difficult, sensitive and long-standing conflict over the proposed development of the Bolsa Chica wetlands region of Southern California.

II. PRINCIPLES OF CONFLICT RESOLUTION

Given the seemingly conflicting goals of the Conservancy in resolving land-use disputes (advance the State's interests while acting as an unbiased mediator), it is important to note an important distinction which exists in the negotiating process as conceived by the Conservancy. The notion of conflict resolution is commonly perceived as a process of "compromise," in which one surrenders a portion of one's goals in return for the attainment of the remainder. This approach is an untenable one for the Conservancy, which is required by law to meet the provisions of the Coastal Act; there is no "compromise" available under these conditions.

The Conservancy instead has approached the conflict resolution process as one of "accommodation," in which one realizes substantially all of one's essential goals, but in a form or approach which was not originally contemplated. In short, while there is little flexibility in the goals the agency pursues, there is tremendous flexibility in the manner in which they are achieved. It is the shaping of these accommodations which forms the core of the conflict resolution process.

The following principles or practices are designed to expedite this accommodation process by answering two primary issues in any dispute: 1. What are the goals of the parties in the dispute? and, 2. What are the options available to meet them? While these may seem to be the obvious part of any negotiation process, in fact it is often the case that a dispute can be resolved by helping the parties involved to clarify their goals and options, rather than by any "hard-ball" negotiating tactics.

REDUCE TECHNICAL DISPUTES TO THEIR CORE

In most land-use disputes, the critical issues are technical in nature. Before serious negotiations can begin, it is essential that the core of these technical disputes be established. This means that, since there are usually as many opinions on a technical issue as there are technicians consulted on it, rival technicians must meet, analyze the issue, and arrrive at the points of agreement or disagreement before there can be a foundation for further discussion. This part of the process is often ignored in land-use disputes, to the detriment of all concerned, as it is impossible to focus discussion before such meetings occur. Moreover, in some fortuitous instances, this kind of meeting can obviate the need for further negotiations altogether, since some disputes can be a function of unclarified plans or definitions of the problem.

ALWAYS TEST ALL ASSUMED OR EXPRESSED GOALS BY PROPOSING ALTERNATIVES.

It is often the case that the parties in a dispute are more sure of what they <u>don't</u> want than what they do want out of the negotiations. Frequently the parties in a dispute, after some discussion of alternative goals, will change their stated objectives during the course of negotiations. For example, a commonly articulated objective of many developers is the "maximization of profit" (which is in many instances more of a wish than a goal). In fact, the real goal may be the manager's desire to preserve his own job by achieving an apparently successful resolution of the controversy. Presenting an alternative goal which does not "maximize" quite as much profit but is well received by the other parties in the dispute will often elicit a shift in stated goals from the developer, who in the end stands to gain more from a resolution than from a stalemate.

PROPOSE AS MANY ALTERNATIVES TO ACHIEVE THE GOALS OF THE PARTIES AS POSSIBLE

Of course, there are limits to this practice. The constraints of staff time and costs, as well as the time needed to complete the negotiations militate against developing an unlimited number of proposals. As a rule of thumb, developing five to seven alternative proposals will usually serve to present a sufficiently large spectrum of possibilities to include the interests of all the parties involved in even a very complicated dispute. These alternate proposals may be somewhat outlandish in their scope and slant, which serves to outline the extreme limits of the dispute. It is also important that the economic implications of the alternate proposals are fully developed, or there will be little basis for comparison between one and the other. This last requirement is particularly important in dealing with developers since the mediator is seeking to assure an equivalent fair return on investment, while still maintaining the State's goals.

REDUCE DISPUTES TO ECONOMIC TERMS

While this requirement seems to be slanted towards the interests of the developer, in fact it is essential for all the parties in the dispute. Clearly, it is impossible to compare the value of commercial development in an area to the value of preserving a wildlife habitat. However, all the parties have a notion of what they hope to achieve in the negotiations (or will have after discussion has clarified their goals). Thus, by reducing the alternative proposals to the question of relative return on investment (How much wildlife habitat will be preserved? How much land will be given over to residential development? How much will it cost to achieve these goals under one plan when compared to another?), a basis for accommodation is formed which could not exist if the discussion were relegated to non-economic, intangible concerns.

EXPAND THE LAND AREA UNDER CONSIDERATION WHENEVER APPROPRIATE OR FEASIBLE

Almost any land dispute can be resolved if one has a large enough land area in which to allocate various uses. The fact that land-use disputes were not prevalent in the past, when there was a tremendous amount of unsettled land, underscores this point.

INCLUDE ALL INTERESTED PARTIES IN THE NEGOTIATIONS PROCESS

Far more often than is realized, a successful negotiation will be thwarted by the failure to include all the parties who have a stake in the outcome of the process. The Conservancy staff has learned this the hard way. In one instance, a dispute which has been resolved to the satisfaction of all the parties involved in the negotiations was nullified because the local government had not been consluted beforehand, and refused to approve the proposal. Although the project was eventually completed, these difficult and arduously arrived at agreements were jeopardized simply because no effort had been made to include the local government in the process (based on the assumption that there was no controversy among the local legislators on this issue).

Unfortunately, the traditional mechanism of holding public hearings to deal with the concerns of all the interested parties in a dispute has not been generally successful, primarily because by the time these hearings take place, the substantive issues in a dispute have already been hammered out by consultants, agencies, and business people. the public consequently perceives that the hearings are at best pro forma, and often reacts by impending the implementation of a project until public input into the negotiations can be dealt with.

The Conservancy has experimented with a number of approaches designed to include the public at the beginning of the negotiations process. The most successful to date has been to conduct public workshops on the issues surrounding the dispute early in the negotiations process. This approach solicits public input early in the process, while at the same time educating the interested parties to all the constraints surrounding the resolution of the issue. This technique was usefully applied in the Bolsa Chica dispute, and will be discussed in the case study.

BE WILLING TO INVEST ALL YOUR RESOURCES, TIME AND CONCENTRATION IN THE CONFLICT RESOLUTION PROCESS.

This caveat applies especially to government agencies, although all groups involved in a dispute should heed it as well. For government agencies (as mentioned earlier) each unresolved conflict adds to all the others, until the acutal product of the agency becomes unresolved conflicts. This piling of one failure upon the next marks the entire program as a failure.

Conversely, each successfully resolved conflict not only solves the immediate problem, but instills a sense of confidence in all the parties involved in such disputes that there is a way to overcome the difficulties. All too often, regulatory agencies fail to recognize this fact, and instead defend their failures by relying on "consistent" administration, or, even worse, by alleging that they are helpless to do anything constructive in the face of their mandate. This attitude on the part of state agencies, or indeed on the part of any interest group with a clearly articulated mandate in the dispute (for developers, make a profit; for environmental groups, preserve a habitat; for local governments, provide recreational facilities, etc.), is one of the greatest impediments to the successful resolution of a dispute. It is essential that all the parties involved in these conflicts use the negotiations process to discover ways in which their particular mandate intersects with the interests of the others in the dispute, rather than using it as a shield from accusations of ineffectiveness of inaction.

III. THE BOLSA CHICA CASE STUDY: APPLYING THE PRINCIPLES

Site Description

The Bolsa Chica study area is located in northeastern Orange county and occupies about 1600 acres of unincorporated land surrounded by developed portions of the City of Huntington Beach and the Bolsa Chica State Beach.

The area consists of two mesas totaling about 300 acres, and a 1300 acre lowland in the center, ofter referred to as the Bolsa Chica gap. The mesas and attendant bluffs are essentially undeveloped, while the lowland is the site of an active oil field operated under long-term leases by two major oil companies. Landownership is split among five different entities, with the largest amount of land owned by Signal Landmark, Inc.

The acreage of wetlands and other environmentally sensitive habitats in the study area varies depending on the source consulted. The State Department of Fish and Game reported in a June 1981 report that there existed a total of 1292 acres of wetland in various stages of degradation, and 88 acres of Environmentally Sensitive Habitat (ESH).

These habitats are scattered throughout the site, although they are mostly concentrated in the lowlands. In addition, the endangered Belding's savannah sparrow and the light-footed clapper rail nest on the site and the endangered least tern feeds in the area's waters.

Site History

Prior to the 1870s, the Bolsa Chica Gap was a large coastal estuary, one of a chain of such wetlands in Los Angeles and Orange counties. It is likely that the wetland was a diverse array of habitats, including brackish and saltwater wetlands. The total area affected by daily tides (called the tidal prism) was large enough to keep permanently open a large outlet to the ocean. The adjacent Anaheim Bay wetlands, which were slightly smaller, had a similar outlet through which ocean-going vessels passed.

By 1921, the Bolsa outlet had closed off due to the construction of tide gates near the outlet, and the creation of a connection to Anaheim Bay. These modifications created large areas of managed, brackish water ponds in the Gap which benefitted duckhunting, but which greatly reduced the area of tidal (marine) habitat.

By 1950, much of the area has been criss-crossed by oil roads and dotted with oil pads and other energy facilities. These developments created a mosaic of ponds with saline bottoms, cut off for the most part from tidal flows but containing enough water during winter for large numbers of shore birds and other water-associated birds.

Planning History

In 1973, Signal Landmark and the State reached a Settlement Agreement concerning the extent of State-owned lands relative to public-trust claims at Bolsa Chica. The settlement agreeement outlined the extent of the State's fee title acreage in the area, as well as several lease and use agreements. As a consequence of this agreement, all public trust easements in the area allocated to Signal were terminated.

In 1978, Orange County formed the Bolsa Chica Study Group to expedite the development of a local coastal plan for the area. Thirty-nine planning alternatives were submitted by this group to the County; nine of these were selected for consideration by the County Planning Commission and Board of Supervisors during public hearings between 1980 and 1982. A final plan was approved for submission to the Coastal Commission in early 1982. this plan called for a number of development proposals, most importantly specifying the restoration/protection of about 600+ acres of wetlands (including boating channels).

In April of 1982, the Commission rejected the County's Land Use Plan (LCP) citing among other things, the plan's deficiency in identifying an appropriate number of wetlands acreage to be restored. The Commission identified 1018 acres to be restored, without boating channels.

The County subsequently withdrew the LUP and began work on a supplemental package to respond to the Commission's concerns. During this period there was a widespread belief that the issues raised by the Coastal Commission could not be resolved between the Commission and the County, and that a new approach was needed. Adccordingly, the State Senate passed SB 429, which allowed a local applicant to request that the Department of Fish and Game, and the State Coastal Conservancy attempt to resolve "fish and wildlife concerns" as they relate to development conflicts through the development of Habitat Conservation Plan (HCP). Under the terms of SB 429, the Conservancy was responsible for developing "alternate land use plans" while the Department was responsible for "wetland determinations." On October 1, 1983, Orange County requested the Department to formally prepare an HCP for the Bolsa Chica Area.

The Parties in the Dispute

Bolsa Chica represents a particularly difficult negotiating problem because the diversity of the parties in the dispute is significant. The issues tied to the LUP involve wildlife agencies at the State and Federal levels, the county of Orange, the City of Huntington Beach, the Coastal Commission, the Environmental Protection Agency, the Army Corps of Engineers, the State Lands Commission and the Department of Parks and Recreation as well as the Department of Fish and Game. In addition, the public parties to the dispute include a constituency of recreational boaters and manufacturers and inland populations that are interested in coastal recreation and access. The environmental interests include local groups such as the Amigos de Bolsa Chica, that are interested in wildlife enhancement, as well as State-wide groups that are interested in establishing precedents that will be applicable to other coastal areas.

The complexity of the interests involved with this dispute prevent a complete discussion of all the issues linked to the LUP and the Senate-mandated HCP. However, the central controversy was over the question of wetlands acreage designation, primarily because it was this determination which would have the greatest impact on the other development issues. This issue also presents the most interesting conflict resolution problem, because the Coastal Conservancy was required to use the Department of Fish and Game's figures in creating the HCP, thus preventing any kind of compromise on this critical issue.

Reducing the Technical Dispute

The first task the Conservancy faced in coping with the wetlands question was to determine what the various technicians in the dispute believed to be the correct wetlands designation. The Bolsa Chica Wetlands are scattered throughout the 1300 acre lowland. Development in the lowland without landfill of some of the wetlands would be almost impossible. The Coastal Act does not normally allow the fill of wetlands for housing or marinas. However, one provision of the Act states that, where the Department of Fish and Game (DFG) determines that a wetland is so severely degraded that it requires major restoration, 25% of the wetland can be developed as a marina or boating facility (or housing) as long as the remaining 75% are restored.

Using this formula, the Various parties in the dispute arrived at the following figures:

DFG: 1018 acres

County of Orange: 621 acres

U.S. Fish and Wildlife Service/Amigos de Bolsa Chica: 1292 acres

Signal Landmark, Inc.: 453 acres

Coastal Conservancy: 951 acres

Although the Conservancy was required to use DFG determinations, the differing figures are the result of an accord reached with the Department concerning the designation of the starting figure, which in the DFG's formula did not include State-owned acreage, which the Conservancy estimate allowed for. These technical determinations were compiled by the Conservancy at meetings with the various technicians involved in the dispute, and provide the basis for the subsequent negotiations.

Providing Alternatives

Having arrived at the starting point for negotiations over the wetlands issue, the Conservancy created fully developed alternatives using the figures provided by the competing parties. These alternatives reflected the extremes of the various proposals, and provided a basis for a comparison of the two major plans (the LUP and the Conservancy's HCP).

The Conservancy's alternate HCP's served several important functions in the negotiating process. First, it tested the goals of the parties involved in the dispute, and in so doing, created a basis for further discussion by identifying common goals among the participants. These goals included creating a plan which promoted: 1. High habitat diversity, 2. low capital and operation costs, 3. Compatibility with public and private development, including current and future oil operations, 4. high predictability of success, and 5. protection and/or restoration of endangered species habitat.

The alternate proposals were presented in economic terms (see exhibits). These measurable economic considerations were an essential component to securing cooperation from the developer, who had for the last 10 to 12 years been attempting to develop the area, and who had at one time been on the verge of an agreement (in the Settlement Agreement with the State). Any plan, to be acceptable to Signal, had to clearly specify the extent of Signal's return under that proposal. As the exhibits show, in every case the alternatives were couched in terms which outlined the return possible.

This presentation of alternatives also clarified the economic realities of the proposal to the other parties in the dispute, who, having agreed that the project should be cost-effective as well as meeting their goals, were able to perceive and act on the accommodations available to them.

Community Participation

The last element essential to the successful resolution of the Bolsa Chica conflict was the inclusion of the public in the negotiations process. Since there were so many public concerns tied to the development of the area, rather than only holding public hearings to review these issues, the Conservancy convened a workshop in April of 1984 to explain and discuss the various complicated concerns of the LUP and the proposed HCP.

The model for this workshop was developed by a member of the Conservancy staff, who based his design on the work of other meeting facilitators. In these workshops, participants actually draw and construct their own ideas. Design consultants synthesize, sketch or model alternatives and ultimately respond to the consensus and a conceptual plan that shows in perspective what the project could look like. Participation was greatly enhanced by going beyond planning concepts and written proposals to graphic visualization. The workshop also educated the parties to the economic, structural, technical, and political elements of the dispute. The end result was that, despite some remaining issues to be resolved, for the first time in ten years, a modicum of consensus was reached on the dispute of wetlands designations.

IV. CONCLUSION

The Coastal Conservancy board approved the Habitat Conservation Plan for the Bolsa Chica region in July of 1984. While there still remain several issues to be completely ironed out among the competing parties, (the re-routing of the Pacific Coast Highway, among others), all of the major parties in the dispute expressed satisfaction with the resolution of the wetlands designation issue. The HCP finally, through some juggling of numbers, designated 915 acres of wetlands to be restored, the largest wetlands restoration project ever undertaken on the West Coast. This figure represents virtually the entire amount of the original Conservancy figure (951 acres), and the fact of its acceptance by all of the parties in a dispute which had raged for ten years suggests that a judicious combination of the principles discussed in this report can yield, in even the most complicated land-use disputes, the beginnings of an accord. While this method is no means as yet fully developed or codified, it does represent a step in the right direction, and as such, should be closely considered by parties involved in other land-use disputes.

Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ.

IS SPECIAL AREA MANAGEMENT PLANNING FOR THE LAKE PONTCHARTRAIN BASIN NECESSARY?

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Introduction

Increasing public attention has been focused on environmental problems encountered in the Lake Pontchartrain-Maurepas Estuarine Complex due mainly to several major issues which include: deteriorating water quality, loss of wetlands, increasing urban development, continuing demand for mineral and biological resources, and increasing recreational activity. Significant population growths have occurred along the north shore of Lake Pontchartrain during the past ten years, primarily a result of upper income families moving from the urban center, New Orleans, to outlying areas. Wetlands surrounding New Orleans have been under severe developmental pressures. Fortunately there are upland areas out of the flood plain to the north of Lake Pontchartrain Basin that are suitable for development.

As demand for residential and recreational opportunities increase around the lake developers begin to invest in projects to meet these expectations. Many of these projects were ill conceived since they failed to consider the natural setting or environmental constraints present such as flooding, shoreline erosion, subsidence and poor water quality. When the developer came to the regulatory agencies they were not prepared to address these problems in a comprehensive manner. As a result, he was confused and often times bitter because there were not detailed guidelines to follow. Consequently, lengthy delays occurred in reviewing permit applications and several projects were scraped after much planning and money was expended. This frustration and costly delays could have been avoided if a detailed basin plan had been in place that clearly set forth what a developer was expected to do to meet the environmental challenges in a particular area of the basin.

With these facts in mind, the formal special area management planning process was initiated in 1982 when two local citizens groups, the Civic Council of East Jefferson along with the Pontchartrain Shores Civic Association submitted to the administrator of the Coastal Management Division of the Louisiana Department of Natural Resources (CMD/DNR), "A proposal for the nomination of Lake Pontchartrain to be designated as a Special Area". The nomination was filed according to procedures established in the Louisiana Coastal Resources Final Environmental Impact Statement of 1980. These procedures provide a means for the designation, utilization and management of special areas, as well as for formulating guidelines and precedence of uses for each area.

The following year a regional conference was held to address the many environmental, economic and political factors influencing the future vitality of the basin. The outcome of this conference was increased awareness of the problems threatening the integrity of the Lake Pontchartrain-Lake Maurepas estuary. This served as an impetus for the Louisiana Department of Natural Resources to initiate the formal identification and examination of regional problems to be considered by the recently nominated Lake Pontchartrain Task Force by Governor Edwin Edwards.

The Task Force is composed of seventeen members representing the eight adjacent parish governments as well as state and federal agencies, private industry, and public interest groups. The large number of representatives is an indication of the complex physical and political nature of this estuarine system.

Description of the Pontchartrain Basin

The Pontchartrain drainage basin represents an area of over three million acres of coastal land and water between the Mississippi and Pearl Rivers (Coastal Environments, Inc., 1984). The area is made up of Pleistocene terraces and uplands north of Lake Pontchartrain, and the Mississippi River deltaic plain forming the southern portion. A large area of shallow estuarine open water dominates the region which includes Lakes Maurepas, Pontchartrain and Borgne. In addition, the New Orleans urban/industrial area encompasses the southern shoreline of Lake Pontchartrain.

New Orleans comprises the major urban/industrial center, and is the only major city the U. S. built entirely in a flood prone area. The industrial corridor between New Orleans and Baton Rouge is one of the largest port complexes in the world. Together the urban and industrial growth of the area is placing the Lake Pontchartrain estuary in jeopardy by threatening expansion into surrounding wetlands, decreasing water quality and depleting its natural resources.

Much of the northern area of the basin falls outside of the Louisiana Coastal Zone Boundary as defined by Act 361 of 1978, as amended (La. R.S. 49:213). Therefore, the actual study area under consideration for special management under jurisdiction of the Louisiana Coastal Resources Program is comprised of all areas below the 5 ft. contour line, with the exception of fastlands (unless the activity is determined to have a direct and significant impact on coastal waters). The study area under management consideration comprises an area of approximately 1.1 million acres of which the major components are 46% estuarine open water, 14% cypress-tupelo swamp, 11% urban/industrial, 8% intermediate and brackish marshes and 7% upland oak-pine forests (Coastal Environments, Inc., 1984). Five major rivers flow into Lakes Pontchartrain and Maurepas and contribute approximately 50% of the freshwater supply into the estuary. The remaining freshwater input is derived from swamps and wetlands in the basin (Van Beek et al, 1982). The Mississippi River no longer contributes freshwater to the system, due to the leveeing of the banks, except during times of high water when the Bonnet Carre Floodway is opened to prevent flooding of the New Orleans area. Marine waters enter via the Rigolets and Chef Menteur Tidal Passes, and the Inner Harbor Navigation Canal (IHNC) of New Orleans. Salinities range from 0 to 8 ppt depending on the wind, tides and freshwater input. Circulation is dominated by wind with tides being important in the eastern portion of Lake Pontchartrain (Stone et al, 1980).

Environmental Issues

The major environmental issues to be addressed by the Lake Pontchartrain Task Force are three inter-related problems of water quality, urban development and loss of wetlands. The greatest source of pollutants affecting water quality originate from the southern shore parishes of Orleans and Jefferson, and to a lesser extent from the north shore area of St. Tammany Parish. These pollutants are from three main source categories; 1) urban runoff, 2) sewage discharge that is treated to less than acceptable levels, and 3) discharges from marine facilities (Schurtz and St. Pe, 1984). A decline in water quality has been documented by Stone et al (1980), who found nutrient inputs to be increasing in recent times, with nearly a doubling of phosphorus loading into Lake Pontchartrain since 1900, and a significant increase in water turbidity since 1953. This can be directly attributed to land use changes from areas that were predominantly forested woods and swamps to agricultural and urban uses resulting in increased runoff, sediment and nutrient loading (Turner and Bond, 1980).

Water quality has also been significantly affected along the south shore by the extensive urbanization since the 1950's of a former wetland. Eleven outfalls occur along this shoreline which results in septic conditions during periods of high rainfall.

Two manmade waterways, the IHNC and the Mississippi River Gulf Outlet have allowed the increased entrance of salt water into the system. This has allowed higher than normal salinities to develop, which in turn have caused increased mortality of cypress swamps and loss of fresh marsh. In addition, zones of low dissolved oxygen have been found in relation to a salt wedge during the summer months when freshwater input is lowest (Coastal Environments, Inc. 1984).

Increased turbidity levels have been attributed to increased land clearing and development, as well as the dredging of Rangia clam shells. However, the physical effects of shell dredging have been shown to be temporary in the water column, with more deleterious effects occurring on the bottom sediments. As the dredge material settles, the bulk density of the bottom is reduced to a fluid consistency thereby permanently disrupting the habitat of benthic organisms by allowing the larger ones to sink in the sediments. In all areas of Lake Pontchartrain where shell dredging is allowed approximately 44% of this fluid mud has been found to persist on the bottom, thereby reducing the overall productivity of the benthic community and the estuarine ecosystem (Sikora et al, 1981).

During the past 25 years, wetland habitats have decreased by approximately 13% in the Pontchartrain-Maurepas Basin due to natural and man-induced causes. The loss of wetlands is a continuing problem for several reasons: 1) reclamation for agriculture and development, 2) canal dredging for oil and gas exploration, 3) saltwater intrusion, 4) shoreline erosion, 5) subsidence and 6) sea level rise (Coastal Environments, Inc., 1984). All of these factors with the exception of sea level rise can be managed to some degree by a comprehensive systems approach to wetland management.

Role of the Regulatory Program

During the 3½ year period since the inception of the LCRP, 261 Coastal Use Permits have been issued in the Pontchartrain-Maurepas Basin. Of these, 29% included dredging, 22% included residential or commercial development, 19% water and erosion control projects, and 10% were for oil and gas exploration. An activity of particular concern with potential impacts on wetlands as well as water quality, has been the construction of marina developments along the Pontchartrain shoreline and adjacent tributaries.

The policy of the LCRP has been to encourage the location and development of marina community developments in non-wetland areas. Three recent marina projects exemplify this land use policy on the north shore of Lake Pontchartrain.

The first of these to fall under the jurisdiction of the LCRP was the Port Louis Marina Community which was granted a permit in 1983 after approximately a year of negotiations. This development is located on 300 acres of agricultural land which had formerly been wetland. The area had been drained in 1965 and most recently used as pasture. Permit conditions placed by the LCRP included the construction of hurricane protection levees, canals designed to enhance circulation, vegetation shoreline stabilization, a beach nourishment program, a stringent water quality monitoring program, tertiary sewage treatment, and a phased construction program which will allow sufficient review of compliance with permit conditions.

In 1983, a similar development, Rigolets Estates, was granted a Coastal Use Permit to construct a 332 acre marina community in a spoil disposal area adjacent to the Rigolets Tidal Pass. Similar permit conditions to those issued for Port Louis were placed on this project. Most recently, Marina del Ray, a much smaller yet equally innovative marina development was permitted to construct a 318 slip floating marina on the Tchefuncte River, a northern tributary to Lake Pontchartrain. The primary location for this project was an abandoned ship building turning basin and associated spoil areas along the river bank. The marina headquarters and future condominium development are designed to be pile supported structures, with an elevated causeway traversing a fresh marsh area to connect the marina with the adjacent highway. For all three projects less than 0.5% of the total area directly impacted wetland habitats. This was only made possible by lengthy negotiations with the Louisiana Coastal Management Division and other agencies. The average time for initial application to issuance of the Coastal Use Permits for these projects was approximately nine months.

Conclusion

If the Pontchartrain-Maurepas Basin had been a Special Management Area with specific guidelines for each Environmental Management Unit (EMU) within the basin the review of these three projects would have been quite different. The entrepreneurs in each case would have had a much clearer understanding of what type of activity could be conducted in each EMU and what was expected of them early on in the process. For instance, in those areas where submerged grassy beds are found, guidelines that would minimize impacts on this fragile habitat would have been in place. Any dredging for a boat channel would have been inappropriate for this area. Guidelines for other areas, such as the previously drained wetlands the Port Louis development occupied, would have been designated for increased development due to previous impacts. Because this former wetland no longer played a vital role in the ecosystem it was suitable for residential and recreational uses. Costly delays and expenses present in all three projects could have been reduced if specific guidelines had been in place to assist resource managers and developers in selecting the most environmentaly suitable areas.

In the process of establishing Special Management Areas other things such as over lapping jurisdiction among resource agencies will become apparent. Often times multiple jurisdiction has led to poor management decisions, denial of responsibility for resource decline, and poor enforcement.

What are the chances that the Pontchartrain Basin will be designated a Special Management Area with specific guidelines to provide for more informed resource decision making?

After all the meetings, discussions and issues are debated, it may become apparent a consensus cannot be reached on a management scheme for the basin. It may become obvious that local governments and special interest groups are still too concerned about each other's motives to make compromises or agree on a set of management guidelines. In the past, the oil and gas industry has been concerned about local government acquiring additional authority over uses of state concern, such as the siting of oil and gas wells extracting additional revenues from production. Local governments on the other hand, have generally felt powerless to influence this industry, they have always been concerned about the state's authority in this area.

It may be impossible to reach a consensus because elected officials, influential citizens and agency representatives hold divergent views on important environmental issues facing the lake system. It is apparent that residential developers, crabbers and fishermen have conflicting opinions on the reasons for poor water quality in the lakes.

Members of the environmental community are frustrated with both the lack of cooperation received from federal and state government in addressing the problem. Some environmentalists doubt whether the present legal jurisdiction is sufficient to solve the problem. Other concerned citizens, question the will of both local and state government to take a strong stand that may be contrary to the financial well-being of mineral and development interests in the basin.

Given all these views, it is possible no consensus will be reached resulting in an aborted attempt to establish more specific guidelines. If specific guidelines cannot be agreed upon the effort may turn out a set of non-specific guidelines that are legally unenforceable. This would lead undoubtly to increased frustration with governmental processes to solve renewable resource issues.

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THE FEDERAL CONSISTENCY GAMBLE

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The fundamental themes of coastal zone management are strikingly similar to those of gambling - risks, resource supply and resource value. The risks in the coastal zone are clear. They include the risks of impacts on natural resources, on past and future capital investments, on the decisionmaking power of public and private interests, and on the options and alternatives available to these decisionmakers.

The federal consistency process established by Section 307 of the Coastal Zone Management Act of 1972 (CZMA) has been characterized as a unique experiment in cooperative federalism and as a mandate for coordination and consultation. But, federal consistency is also a risk management tool. When envisioned by the Congress when the CZMA was passed, federal consistency was an attempt to protect the investment of federal funds to be spent on the development of state coastal zone management programs, to protect state planning efforts from uncoordinated and inconsistent actions which could adversely impact coastal resources, and to protect the ability of the states to implement their federally approved coastal zone management programs.

The CZMA requires each federal agency conducting or supporting activities directly affecting the coastal zone to conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with the federally approved state coastal zone management programs (Section 307(c)(1) and (2)). The CZMA also requires that federally licensed or permitted activities affecting land or water uses in the coastal zone, including activities described in detail in Outer Continental Shelf (OCS) exploration, development and production plans, be conducted in a manner consistent with federally approved state coastal management programs

The views in this paper are those of the author and do not necessarily represent the official views of the National Oceanic and Atmospheric Administration.

(Section 307(c)(3)(A) and(B)). In addition, federal assistance funds for state and local government projects affecting the coastal zone may not be allocated unless the proposed project has been certified as consistent by the state (Section 307(d)).

Top Billing Events

A number of recent federal consistency events have received top billing. In January, 1984, the U.S. Supreme Court decided in Secretary of the Interior et al. v. California et al. (104 S. Ct. 656) that OCS lease sales are not activities which "directly affect" the coastal zone and are, therefore, not subject to the federal consistency requirements of Section 307(c)(1) of the CZMA. Swift action by a number of U.S. Senators and Representatives followed. Legislation was introduced in both Houses to overturn the Supreme Court's decision by amending Section 307 of the CZMA (H.R. 4589 and S. 2324). Strong opposition to the proposed legislation by the Administration and a number of industries developed quickly.

At the same time, the National Oceanic and Atmospheric Administration (NOAA), in response to the Supreme Court's decision, began deliberations on whether the existing regulations would need to be revised. In an Advance Notice of Proposed Rulemaking (ANPR) published on June 1, 1984, (49 FR 22825), NOAA asked four questions:

1. Are any federal activities outside the coastal zone, other than OCS leasing, subject to Federal consistency requirements?
2. Should NOAA develop a regulatory definition of "directly affecting"? If so, what should that definition be and what legal support is there for that definition?
3. Should NOAA adopt new regulations to encourage early state/federal collaboration, in order to help assure that subsequent activities can be conducted harmoniously with state coastal management programs?
4. Are other changes to NOAA's federal consistency regulations needed?

The public comment period ended on August 31, 1984. NOAA is currently analyzing these comments and considering whether to commence formal rulemaking.

In another area of major events, ten appeals to the Secretary of Commerce to override state consistency objections (under 15 CFR 930, Subpart H) have been filed since December, 1982. Three appeals involved state objections to OCS exploration, development and production plans in the Santa Barbara Channel of Southern California. Four appeals were filed on state objections to Corps of Engineers' dredge and fill permits for marinas and other small development projects in North Carolina, San Francisco Bay, and Washington State. Another appeal was filed on an objection by the California Coastal Commission to the abandonment of a railroad line in Northern California. The City of Hudson filed an appeal on an objection by the State of New York to federal assistance for a gasification plant to be located along the Hudson River. In a multiple action, the Corps of Engineers filed an appeal to objections raised by six states to a number of the Corps' proposed nationwide permits. These appeals are currently under review by the Secretary. The Secretary's decisions will be announced to the parties and in the Federal Register.

How Do You Play The Game?

For those who play the game or want to know how, the rules are found in the National Oceanic and Atmospheric Administration's (NOAA) regulations at 15 C.F.R. 930.

Who Are The Players?

The "high rollers" include those federal agencies with responsibilities for resource management, protection and development, and for advancing the national interest in defense, economic well-being and environmental protection; the States; and the major industries with investment in the resources of the coastal zone and the OCS. Besides the "high rollers" there are alot of "mom and pop" players affected by the federal consistency process: including the small marina developer, towns trying to solve sewage treatment problems, individuals improving or protecting residences, and citizens concerned about the quality of the coastal environment.

What Are The Odds Of Winning?

Perhaps the simplest, most pragmatic definition of a "win" is when all interested and affected parties can agree on whether and how a proposed project can go forward.

In 1982 NOAA conducted an informal telephone survey to find out how well the federal consistency system was working - just what were the odds? Of the approximately 300 to 400 federal agency actions reviewed by the states for consistency during 1982, under Section 307(c)(1) of the CZMA, there were objections in approximately 3-4% of the cases. Of the approximately 6500 to 7500 federally licensed and permitted activities reviewed, under Section 307(c)(3)(A) of the CZMA, objections occured in about 2% of the cases. Of the approximately 500 federally licensed and permitted activities described in detail in OCS plans reviewed by the states under Section 307(c)(3)(B), objections occurred in approximately 0.5% of the cases. And finally, of the approximately 600 federal assistance proposals reviewed under Section 307(d), the states objected in about 0.5% of the cases.

In 1984, NOAA began a comprehensive review of the federal consistency process to learn more about the implementation of the federal consistency process. (See 49 FR 35541-35542, September 10, 1984, for discussion of the elements of the study.)

Preliminary results based on an examination of NOAA's files of objections show a total of 97 unresolved objections by the states during 1983, with the Corps of Engineers and the Department of the Interior as the "big losers". (See Table 1). (States are required by NOAA regulations to notify NOAA whenever they do not concur on a consistency determination or certification. There is no regulatory reporting requirement on states to report concurrences or total number of federal activities reviewed for consistency. NOAA has no regulatory reporting requirements applicable to other federal agencies.)

TABLE 1. Federal Consistency Objections - FY 1983 *

Federal Agency	Section 307 category (c)(1)	(c)(3)(A)	(c)(3)(B)	(d)
Corps of Engineers	4[2] **	948[79]	0	0
Navy	0	0	0	0
Air Force	0	0	0	0
Coast Guard	3[1]	0	0	0
Minerals Management Service	9[5]	0	4[3]	0
Bureau of Land Management	2[0]	0	0	0
National Parks Service	1[0]	0	0	0
Forest Service	1[0]	0	0	0
National Marine Fisheries Service	4[4]	0	0	0
Environmental Protection Agency	1[0]	0	0	0
Housing and Urban Development	0	0	0	0
General Services Administration	1[0]	0	0	0
Federal Aviation Administration	0	0	0	1[0]
Federal Highway Administration	0	3[2]	0	2[1]
Federal Railway Administration	1[0]	0	0	0
Interstate Commerce Commission	0	1[0]	0	0
Total	24[12]	952[81]	4[3]	3[1]

* This is preliminary data only. NOAA is in the process of confirming this information through the Federal Consistency Study. The data does not include the total number of actions reviewed for conistency by the states.

** Initial Objections [Unresolved Objections]

Is The Table Rigged? Is The Wheel Unbalanced? Do The Statistics Tell All?

NOAA can't currently answer these questions, but more qualitative and quantitative information is being gathered as a part of the Federal Consistency Study. Statistical information on the federal consistency process cannot fully illustrate or describe how the federal consistency process actually works. For example, a compilation of statistics on concurrences and non-concurrences can provide little insight into the informal negotiations which have occurred between the various interests, the development of conditions and mitigation measures to achievea consistency concurrence, or the substantive areas of conflict between interests. Likewise, a compilation of statistics can offer little guidance on how to remedy any problems or to improve the process. Therefore, NOAA's Federal Consistency Study is drawing information from a large variety of sources and will specifically examine the experiences of affected parties regarding, for example, the average length of time for state consistency reviews, the use of pre-application conferences and early coordination mechanisms, the use of conditional and general concurrences, and experiences using negotiations and/or mediation to resolve conflicts.

The Federal Consistency Study will include:

(a) Statistics on the numbers of concurrences and non-concurrences on consistency determinations (prepared by federal agencies for Section 307(c)(1) activities) and certifications (prepared by applicants for federal licenses and permits under Section 307(c)(3) activities and financial assistance under Section 307(d));

(a) brief summaries of consistency cases considered especially significant by the states, the federal agencies, and/or other interested parties;

(b) a compilation of information, to the extent it is available, regarding the administration of the federal consistency process; and

(c) brief summaries of major issue areas identified by states, federal agencies, industry groups, and public interest groups.

NOAA anticipates having the Federal Consistency Study available by Spring, 1985.

A Quick Glance At The Players Hands

A preview of issues which may need to be addressed through administrative, regulatory, or legislative means can be gained by reviewing the comments NOAA received on the Advance Notice of Proposed Rulemaking. Although NOAA has not completed its review of these comments, they are available for public inspection at the Office of Ocean and Coastal Resource Management in Washington, D.C.

The Final Score????

The results of the Federal Conistency Study will no doubt provide a better information base upon which to make decisions about any problems and solutions, but the final solutions will probably be long in coming. The issues are likely to be hotly debated in the rulemaking arena and the legislative arena when the CZMA is considered for reauthorization in 1985. Only the truly adventuresome game player would attempt to predict the outcome now.

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IMPLEMENTING THE COASTAL BARRIER RESOURCES ACT

Frank McGilvrey

US Fish and Wildlife Service

Implementing the Coastal Barrier Resources Act

This paper discusses Department of the Interior (DOI) responsibilities under the Coastal Barrier Resources Act (CBRA) and where we are with implementation two years after passage of the law.

Through CBRA, Congress has declared that not only are coastal barriers a very important and unique natural resource, but that they are generally unsuitable for development. The law recognizes that many Federal programs have encouraged unwise development. In a move to prevent further subsidization of such development, CBRA established a Coastal Barrier Resources System (System) of 186 unprotected, undeveloped coastal barriers on the Atlantic and Gulf Coasts. Within this System, with a few specific exceptions, all Federal expenditures and financial assistance are banned.

Each of the some thirteen Federal agencies impacted by CBRA have the responsibility of incorporating the law's requirements into their programs and policies. CBRA requires that each agency certify annually to the Office of Management and Budget (OMB) that it is in compliance. OMB in turn must certify to Congress that all Federal agencies are in compliance.

It is important to note that only Federal expenditures and financial assistance within the mandated units of the System are affected. State, local and private expenditures are not affected.

A number of specific responsibilities were delegated by the Act to the Secretary of the Interior. The Secretary has redelegated most of these responsibilities to the Fish and Wildlife Service (FWS) or the National Park Service (NPS). The status of these responsibilities is the focus of this paper.

Sec. 4(a)(2) of CBRA allowed landowners of qualified areas to voluntarily add their lands to the System. This provision expired on October 18, 1983, without being used.

Sec. 4(b)(1)(2) provided guidelines for distribution of maps of the System. Maps are available for review at pertinent U.S. Fish and Wildlife Service Field and Regional offices and State and local jurisdiction offices. These maps may be purchased from the U.S. Geological Survey.

Sec. 4(c)(1) authorized minor and technical adjustments of unit boundaries within 180 days of enactment. A very strict interpretation of this provision resulted in 17 minor additions and 2 minor deletions within 19 units. Any further change to the Coastal Barrier Resources System requires amending of the Act except as provided for in the next part.

Sec. 4(c)(3) requires the Department to adjust unit boundaries, if necessary, at five year intervals to account for natural forces. The Fish and Wildlife Service will carry out the first iteration of this requirement in 1987. Any changes will be based on a comparison of 1982 aerial photography with new photography in 1987.

Sec. 6 lists the specific exceptions to the general ban on Federal expenditures within the System. They are divided into two categories; activities allowed without condition, and conditional activities. Conditional activities must meet the three purposes of the Act. Those purposes are to minimize:

1. Loss of human life;
2. wasteful Federal expenditures;
3. damage to fish, wildlife and other natural resources of the System.

Non conditional activities include:

1. Certain energy activities;
2. maintenance of shipping channels;
3. maintenance of essential roads and utilities;
4. essential military activities;
5. Coast Guard facilities and activities;

Conditional additional activities include:

1. fish, wildlife and recreational projects;
2. air and water navigation aids;
3. Land and Water Conservation Fund and Coastal Zone Management Act activities;
4. scientific research;
5. emergency Disaster Relief;
6. maintenance of non-essential roads and utilities;
7. nonstructural projects for shoreline stabilization.

Prior to obligating Federal funds for any of these exceptions, the agency must consult with the U.S. Fish and Wildlife Service, Department of the Interior. The role of the FWS under Section 6 of CBRA is similar to its consulation role under Section 7 of the Endangered Species Act. When the FWS receives a request for consultation on an expenditure contemplated by a Federal agency, the FWS prepares an opinion as to whether the proposed expenditure fits within one of the Section 6 exceptions and is therefore legally permissible under CBRA. If a proposed activity is conditional, the FWS provides a further opinion on whether the activity meets all three purposes of CBRA. The action agency then utilizes this opinion in determining whether to proceed with the proposed expenditure.

An October 6, 1983 Federal Register notice provided DOI policy and guidelines on Federal programs affected and the FWS proposed consultation process. Internal guidance has also been developed.

Fourteen Federal programs have been identified as being affected by the exceptions. Each concerned agency has designated a CBRA coordinator and has developed policies and guidelines to implement the consultation requirement. Most of the consultations to date relate to channel, road and utility maintenance. One hurricane, Alicia in Texas, has occurred since CBRA became law. To avoid any delay in implementing the emergency procedures of Sections 305 and 306 of the Disaster Relief Act, the FWS participates on the Disaster Relief teams and waves formal prior consultation for these activities. Permanent repair or replacement of public facilities on CBRA units with Federal Emergency Management Agency (FEMA) funding requires formal consultation. A smooth and effective consultation process has been developed with FEMA as the result of the Alicia experience.

Most consultations have been free of serious controversy. The most serious controversy to date has involved the reconstruction of a section of State Highway 87 in northeast Texas. The FWS was of the opinion that this segment was non-essential and repeated reconstruction due to hurricane damage was a waste of Federal money and threatened human life. The Federal Highway Administration disagreed with this opinion and will fund reconstruction.

Section 10 is a three year study required of DOI. A DOI study group chaired by the National Park Service, and including the Fish and Wildlife Service, and U.S. Geological Survey, with participation of representatives from other affected Federal agencies, is doing the study. CBRA requires two broad results from the Study:

1) Recommendations for the conservation of the fish, wildlife and other natural resources of the System, based on an evaluation and comparison of all management alternatives and,

2) recommendations for additions to, or deletions from the System.

To fulfill the management alternatives requirement, the Study Group has:

A. designated individuals to prepare chapters on the resources of coastal barriers, direct and indirect Federal programs impacting the barriers, permitting, the tax code, and Federal acquisition programs;

B. designated four Regional Study Leaders to review the effectiveness of State and local programs;

C. developed revised criteria for proposed substantial additions to the System. Broadly these additions may include:

    1. additional wetlands associated with present units;
    2. otherwise protected areas such as refuges and parks;
    3. barriers within large embayments; e.g. Chesapeake Bay, Tampa Bay, Naragansett Bay;
    4. features functioning as barriers; e.g. - Florida Keys, mixtures

of consolidated and unconsolidated materials as found in New England, and mangroves in tropical and subtropical areas;
5. other geographical areas, including the Great Lakes, West Coast, Caribbean, Alaska, Hawaii, and Pacific Territories.

Drafts of the chapters relating to management alternatives are nearly completed. Proposed additions to the System have been reviewed by the affected States. In January 1985, a Federal Register notice will announce the availability of the draft study and maps for a 120 day public review. The Governors of the affected States will be solicited for their position on the study and the proposed changes to the System.

From the results of this review, a final report and atlas will be transmitted by the Secretary of the Interior to Congress in October 1985. Any changes in CBRA or additions to or deletions from the System will require action by Congress.

Conclusion

It is still too soon for definitive measurement of CBRA's impact. However, certain trends can be seen.

In general, those areas in the System with no development or access may remain undeveloped. Some units on coastal barriers already partially developed and accessible are being developed without Federal assistance. Many loopholes, such as casualty losses and the exceptions, still permit a drain on the Federal Treasury.

Because CBRA only relates to undeveloped coastal barriers, the Federal presence on developed coastal barriers remains very large. A major hurricane could have a substantial impact on the Federal treasury. The very major question of how to handle this issue is unresolved. It will be addressed at the January 1985 Conference on the Management of Developed Coastal Barriers in Virginia Beach, Virginia.

CBRA is a framework. State and local jurisdictions must compliment it if the concept is to be effective. It is a new approach. It is not perfect and does not completely meet the purposes of the Act. But at least it reverses the dichotomy of the Federal government acquiring coastal barriers to stop development on one hand and providing assistance for new development on the other. We must have State, local and public support and action to further expand the effectiveness of the concept.

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SHORELINE EROSION AND REGULATORY PROCEDURES IN THE LOS ANGELES AREA

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General Information

I don't know of another county that has a procedure for building and safety plan check like the County of Los Angeles. Their Building and Safety plan check procedure includes a policy that any structures built on the shoreline must have a Coastal Engineering report.

That report involves, determinations of design waves, a minimum beach profile, or what we sometimes call a design beach profile, design tides and a number of parameters involving the height, depth and length of protective seawalls and protective structures. It is these calculations that are necessary to build a seawall, a pile structure or any type of structure to support and protect the buildings that are built on the beaches of Los Angeles County.

I would like to talk specifically about the area of the coastline between Santa Monica and the Ventura County line. Most of this area is referred to as Malibu. There is a small area just West of Santa Monica that is often referred to as Pacific Palisades.

The process of plan checking involves four or five very important disciplines. It includes the geologist that is primarily concerned with the slides in the area. It includes the structural engineer, who does the basic design. It includes a soils engineer who determines what passive and activity and soil loads are involved and what the soil can stand, and it includes a coastal engineer, who provides information that was aforementioned.

The coastal engineer may also do the structural work, the soils engineering and the surveying. It depends on what his background is.

The surveyor is a registered surveyor or a registered civil engineer that is a specialist in shoreline surveying. He is not just a civil engineer that has had surveying 1A or 1B in college.

The surveying knowledge required to do good work on the shoreline requires some background in geodetic surveying and a keen knowledge of surveying equipment and methods. He also has a keen knowledge of the accuracies needed to establish base lines, cross-sections, range lines and determination of distances and elevations under all sorts of adverse conditions. The reason I emphasize these qualifications is because there is a tendency to assume that the surveying accuracy for beach surveys does not require the technical knowledge that of more sophisticated upland surveying. I would like to make it clear that surveying the shoreline requires a lot more sophistication than the ordinary tract or upland surveys.

The reader should be aware of some of the problems that exist in the Los Angeles County. In the first place, we have a tidal change that can be as large as 10 feet. The tides may extend a distance of more than 2 feet below mean lower low water to a point more than 7 feet above mean lower low water datum.

The beach is generally made up of three parts. As you walk towards the ocean, you walk across a flat section that we refer to as the backshore beach. Then the observer intersects the shoreline that steepens toward the water. This slope is called the foreshore slope. It ranges in the Malibu area from about +1 foot above mean lower low water to an elevation of +11 or +12 feet above mean lower low water. The slope below the foreshore slope flattens and extends into the turbulent surf zone. This slope will not be as flat as many beaches in California, but if often has a slope of around 35 feet horizontal to one foot vertical.

Scores of surveys in this area of the shoreline in Malibu show that the beach is not continuously eroding or accreting, but is oscillating around an average position. This oscillation amounts to approximately 80 feet. That is to say it oscillates about 40 feet on either side of an average. Because of the shoreline oscillation and the fact that the tide and submerged lands are owned by the State of California makes the engineer concerned about intruding on State owned lands. As a result, the policy is to attempt to construct all structures at least 10 feet shoreward of the most shoreward recorded mean high tide line.

Most of the mean high tide lines, of course, are found close to the average position of the foreshore slope. The mean high tide lines are about 1/3 the way up the foreshore slope. It is this part of the beach that erodes and accretes. The foreshore slope usually has the same rate of slope as it moves. When the shoreline does oscillate to an extreme seaward or shoreward position, it only remains there for 3 to 4 weeks and it again returns to the average position. If you arbitrarily picked any given day and went down to the beach, the chances are that the beach would be in its average position. It is rare to find it in either an extremely shoreward position or extremely seaward position.

Therefore, the engineer knows at some point in time the shoreline will recede to a minimum position and he designs the building in a fairly extreme shoreward position. This means that the seawalls and the protective structures that are placed on the beach do not cause shoreline erosion problems. This also makes the size of the structures needed to resist wave action smaller.

As a matter of fact, this policy in the County of Los Angeles started prior to 1965 when I was asked to provide some type of criteria or manual that would protect the buildings along the shoreline from falling in the water. I thought the problems of getting structures properly designed by private engineers would be simply a matter of listing a number of distinguished civil engineers and pass that information out to the developers. I quickly found out this was not the answer. Most of the civil engineering firms were not interested in doing the design of a $40,000 or $50,000 seawalls for a single family dwelling.

At this point the reader should be made aware of the fact that in the Malibu area many of the people are wealthy and, as a matter of fact, many of the people you would know if I gave you their names because they are internationally and nationally famous. The property they own is usually expensive and they usually can afford and want to afford first class shoreline protection and they are willing to pay for it. This situation may not be the case in every area of the United States but since many parcels of property and the houses on them are running in excess of a million dollars, it makes good sense to protect them with the best protection. Not to speak of the fact that at times there is a danger to the people living there.

In finding out that I could not get private engineers to do the coastal work, I decided to teach classes in coastal engineering and invite private engineers to take the classes. Therefore, when I train people, they learn how to use the statistics the County of Los Angeles has developed as a result of a great many surveys over a large number of years. In addition to the surveys that have been developed, wave design summaries were provided. This enabled the coastal engineer to caculate the necessary wave loads for the different types of protective structures without going through huge massive studies of island sheltering, defraction, refraction and many other things that would make a practical and economic design difficult.

The purpose of this report is not to deal with the engineers but with the regulatory procedures that are involved.

The next step then was to require a private civil engineer that had been trained to provide a coastal engineering report to determine the necessary parameters for the protective structures.

In doing this he would provide a report that would include the necessary wave loads, wave uprush heights, design beach profiles and other things that would be needed by the structural engineer to complete the design of the buildings.

The coastal engineering report was then reviewed by the County of Los Angeles, coastal engineering section, and the design was reviewed by our building and safety office and soils engineer. An agreement was also worked out with the State Lands Division of the State of California. That agreement was that they would review the Plans and Specifications for any new building to make certain that there was no intrusion on tide and submerged lands.

This turned out to be very valuable because in the ensuing years when questions arose over tidal boundaries, the tidal boundaries had already been approved by the State of California. And since this agreement was very important, the approval had to be issued prior to the time that construction started.

During the winter of 1982-83, we had the worse oceanwave storm conditions that we have had in many years. At that time the County Building and Safety Office surveyed all the structures that were damaged. There were 59 structures damaged that had been processed through the County Engineer-Facilities Office. Of all the 59 damaged, only 1 was designed and built after 1965. The significance of this is that it was 1965 when the coastal engineering reviews were requested for coastal structures. After this program was instituted in the County Engineers Office there have been over 2,000 shoreline structures built and only 1 failure.

The County of Los Angeles is now in the process of preparing a complete manual covering the engineering methods and parameters that are being used. This has not yet been published and the details of these procedures will be made public in probably the not too distant future.

In my 30 some years of doing this work, I have never met a single individual who had enough knowledge to do an adequate job on all facets of the structural design. It takes a team involving a coastal engineer, surveyor, soils engineer, geologist, and a structural engineer or at least a civil engineer with a sufficient background in structures to do the necessary work to complete this type of work. The team effort has obviously been successful and the procedures and processing details need not be cumbersome but can be worked out in a way in which the turn-around time is not a disadvantage to the developer.

As a matter of fact, from the economic standpoint, the insurance rates in the Malibu area for storm damage is the lowest of any place in the United States. Secondly, many structures that people have attempted to place during my many years of service have been structures that would have cost 2 or 3 times what they needed to cost if it were not for accurate coastal engineering work. No matter how big something is built, if the knowledge of the shoreline geomorphology is not clearly evident, then the developer will be wasting his money, and it is not necessarily true that the bigger is better. Sometimes the huge massive structures still don't work because the engineers did not realize certain facts about the shoreline processes.

The final procedure in the regulatory analysis of the County of Los Angeles requires the private Coastal Engineer to inspect the structure and to sign a statement that the structure has been constructed in accord with the plans and specifications.

If an engineer is not willing to accept this responsibility, then, in my opinion, he has no business doing this type of work. If he isn't confident that the structures will stand up, then he shouldn't be involved.

As a matter of fact, the Coastal Commission of the State of California now requires that an engineer certify that every structure built will stand the ocean wave storms of the winter of 1982-83. I think this is a very good requirement. It puts the ball right into the court of the civil engineer and makes him responsible. If he isn't willing to be responsible, then he has no business doing the work.

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MISSISSIPPI MARINE RESOURCE MANAGEMENT AND COASTAL INDUSTRIAL DEVELOPMENT: AN ANALYSIS OF CONFLICTING MANDATES

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Introduction

The Mississippi coast is protected by a chain of barrier islands and the Mississippi Sound - a large, shallow estuary connected to the mainland by rivers, bayous, and wetlands. The area provides important wildlife habitat as well as a major source of recreation for coastal residents and tourists. Mississippi's commercial and recreational saltwater fisheries and tourist industry are all highly dependent upon the health of this marine ecosystem.

At the same time, Mississippi's ports and harbors, the primary sites for heavy industry on the coast, form an essential part of the State's economic base. However, as was recognized in national and State legislation of the early 1970's, uncontroled industrial development can upset the crucial balance of the wetlands ecosystem and lead to a number of other problems associated with use conflict.

National concern for the wise use and management of our coastal resources led to passage of the Coastal Zone Management Act of 1972,[1] and at the State level, to passage of the Mississippi Coastal Wetlands Protection Law (1973)[2] and Coastal Program.[3] One result of Mississippi's transition from a policy of virtually unrestrained industrial development to the more recent balanced approach reflected in these laws is the altered role of port authorities and industrial development commissions in marine resource management. The purpose of this paper is to examine the relationship between the industrial development of port and harbor areas and Mississippi's relatively new policy of marine resource management. It discusses conflicting statutory mandates embodied in the enabling legislation of county port authorities and commissions, and the relatively new Wetlands Protection Law and Coastal Program.

The first part of the paper relates the primary State framework for managing marine resources. The second part discusses the role of county port and harbor authorities in marine resource management. The final section contains recommendations that would assist the Mississippi legislature and other coastal resource managers in clarifying areas of conflicting policy and jurisdiction to help facilitate reasonable development of the State's coastal resources.

Mississippi Coastal Wetlands Protection Law and Mississippi Coastal Program

The Wetlands Protection Law and Coastal Program jointly address the management and use of coastal marine resources in Mississippi's three coastal counties (Harrison, Hancock and Jackson), including all adjacent waters within the three-mile territorial limit. These laws express a public policy that coastal wetlands should be preserved, except where the alteration of a specific wetland would serve a higher public interest.[4] (Miss. Code §49-27-3) To carry out this policy, the Coastal Program establishes a permitting procedure which is administered by the Bureau of Marine Resources (BMR), under the auspices of the Commission on Wildlife Conservation. The ultimate decision to grant, deny, or condition a permit belongs to the Commission, which depends heavily upon the advice and recommendations of the staff of BMR.[5]

Ostensibly, any activity that affects coastal wetlands is a regulated activity and subject to the permit process. Since some activities conducted outside the wetlands may affect the wetlands, a permit may also be needed for certain activities beyond the three country coastal area or for activities on upland areas.[6] However, not all activities affecting coastal wetlands are subject to the permitting procedures of the Wetlands Protection Law and Coastal Program. Only five types of activities are specifically regulated: (1) dredging, excavating or removing any materials from the wetlands; (2) direct or indirect filling of the wetlands; (3) killing or materially damaging any wetland plant or animal; (4) erection of structures which materially affect the ebb and flow of the tide; and (5) erection of structures on suitable sites for water-dependent industry.[7]

Furthermore, not all activities that fall within these five categories are subject to the review and compliance procedure. As a result of political pressures, nineteen exemptions from the permit process were written into the Coastal Program. Five of these statutory exemptions are particularly important to this paper: the Biloxi Bridge and Park Commission, Biloxi Port Commission, Long Beach Port Commission, Pass Christian Port Commission, Pascagoula Port Commission, and any municipal or local port authorities; the activities of the Hancock County Port and Harbor Commission affecting wetlands within its jurisdiction; the activities of the Harrison County Development Commission affecting wetlands within its jurisdiction; the activities of the Jackson County Port Commission affecting wetlands within its jurisdiction; and the activities of the Mississippi State port at Gulfport affecting wetlands within its jurisdiction.[8]

The same section of the exemptions statute goes on to limit these exceptions by stating:

"All parties or agencies exempt from the regulatory provisions, whether by name or reference, when carrying out what would otherwise be regulated activities in Coastal Wetlands shall at all times adhere to the policy as set forth in section 49-27-3 and each such agency shall further advise the council [now the Commission] of all such activities so that the council may be fully advised of all activities in the coastal wetlands."[9]

The Coastal Program sets out the specific procedure by which BMR must be notified of any exempted activities that would affect the wetlands. BMR is then required to make a finding that the activities are conducted in accordance with the public policy of the Wetlands Protection Law before the proposed activity can begin.[10]

The Coastal Program guides the decisions of the BMR by setting out management goals, implementation procedures, and decision-making guidelines. The goals are designed to promote decisions that balance development with the environment. The first two goals are illustrative of this attempt. The first goal provides for reasonable industrial expansion on the coast that ensures that waterfront sites are conserved for water-dependent industry. The second goal restates the public policy of the Coastal Wetlands Protection Law of favoring the preservation of the coastal wetlands and ecosystems except where a higher public interest is served.[11]

All State and Federal agencies must carry out their responsibilities in the coastal area in compliance with the Coastal Program. To ensure this, the Coastal Program includes policy coordination procedures,[12] as well as enforcement procedures[13] in the event that an agency proceeds in a manner contrary to the MCP.

In making its decisions on permit applications and findings of compliance for excluded activities, BMR and the Commission are obligated to consider a variety of factors. The public interest is evaluated through a review of applicable legislative or judicial statements of public interest, precedent-setting effects, the national interest, public comments, and provisions of any applicable plan. Impact on the wetlands is assessed by examining the direct and indirect effects on the ecosystem, all intended and unintended but reasonably anticipated impacts of the total proposed project, and the preservation of natural scenic qualities. Economic interests are considered by looking at the extent to which adverse impacts can be avoided through modifications, the availability of feasible alternative sites and the need for a waterfront location.[14]

Because of their economic and recreational importance, certain coastal areas have been designated as special management areas (SMAs),[15] for site-specific planning and management. The decisions that go into SMA planning are based on the same criteria as those used for permit decisions at both Federal and State levels. They also allow coastal resource managers to coordinate regulatory decisions with the affirmative development efforts of the coastal program and of local governments. These affirmative development efforts include among other things, energy facility siting, shoreline erosion and mitigation, construction of public facilities such as sewer, water, and drainage systems, and designation of areas for preservation and restoration.[16]

Five industrial and port areas have developed SMA plans, each managed by the appropriate County Port and Harbor Commission: Port Bienville Industrial Park, Pass Christian Industrial Park, Bayou Bernard Industrial Park, Pascagoula River Industrial Area and Bayou Casotte.[17] However, because SMA planning is voluntary, it will only be as effective as the efforts put forth by the resource managers in the special management area.

The Role of County Port Authorities

The Wetlands Protection Law and Coastal Program together evidence the intent of the legislature to promote decisions in the coastal area that balance development with conservation of the environment. As will be seen from the following discussion, that intent often leads to conflicts that are difficult to resolve. A significant number of industrial sites on Mississippi's coast are located in or managed by port authorities. For example, Port Bienville Industrial Park, covering 2,600 acres of county owned land, is managed by the Hancock County Port and Harbor Commission; and the Bayou Casotte Industrial Area and Pascagoula River are managed by the Jackson County Port Authority. This part of the paper will focus on the effect of county port authorities' decision-making for marine resource management.

Section 59-9-1 of the Mississippi Code, originally passed by the State Legislature in 1956, sets as State public policy the expansion and development of Mississippi's ports and harbors.[18] In addition to vast powers and duties to maintain and operate their harbors and ports, county port commissions are given "full jurisdiction and control of any and all lands lying within, or adjacent to, any river, bay or natural lake which are now, or heretofore were, below the mean high tide mark, and which lands lie within or adjacent to any port or harbor" managed by the port authority.[19] Such lands may also be reclaimed by the port authority for operation and development of the port.[20]

Furthermore, a 1982 amendment of the Mississippi Code gives one particular port commission the authority to lease certain acreages,[21] and a 1982 amendment states further that such leasing for development purposes serves a higher public interest in accordance with the public policy of the State as set forth in the Wetlands Protection Law.[22]

Policy and Jurisdictional Conflicts

An analysis of the role of port authorities and commissions in attracting industry, considered in conjunction with the mandate of the Wetlands Law and Coastal Program to balance economic development with sound environmental management of Mississippi's marine resources, reveals two major problems: ambiguous, overlapping grants of jurisdiction and unclear, sometimes conflicting statements of public policy.

The public policy of encouraging development of Mississippi ports is derived from a section of the Mississippi Code which was passed in

1956. At that time the State government realized it was necessary for Mississippi to supplement its primarily agricultural economy with industry, for more balanced economic development. Ports and harbors were a logical place to encourage such development. However, as stated earlier, passage of the CZMA in 1972 and the subsequent passage of the Wetlands Protection Law in 1973 reflected a recognition that unwise development in coastal areas was resulting and in permanent, adverse changes to coastal ecological systems. These laws established a new policy of balancing economic development of coastlines with the preserving of the ecological integrity of the marine environment.[23] Thus, after 1973, the State had two potentially conflicting policies regarding the development of marine resources: one, reflected in the port legislation, favors the largely unrestricted industrial development of port areas; the other reflects the desire to protect and preserve coastal wetlands and their ecosystems (of which port areas are a part) except where alteration of a specific wetland would serve a "higher public interest." Unfortunately, not only is the public interest ill-defined, but "higher public interest" is not defined at all.

A close reading of Mississippi's laws leads to the conclusion that the State legislature intended for port development to fall under the more restrictive policy of controlled growth. For example, the first stated goal of the Coastal Program provides for reasonable industrial expansion and for ensuring the conservation of waterfront industrial sites for water-dependent industry.[24] Furthermore, since the 1982 amendment cited earlier specially designates the development of certain tracts of land to be of higher public interest than preserving those wetlands, it is arguable that the legislature intended for other wetlands in industrial areas to be developed in accordance with the principles and guidelines of the Coastal Program.

Interacting with the conflicting public policies is the issue of jurisdiction over the marine resources of the coastal ports. As stated earlier, the Wetlands Protection Law exempts port authorities from the need to secure a permit for regulated activities. However, the code section states further that all exclusions are still bound by the public policy provisions of the Wetlands Law.[25]

The Coastal Program establishes a procedure for ensuring that the excluded activities are in compliance with the public policy of the Wetlands Protection Law. First, parties proposing to conduct activities covered by the exclusions must notify BMR of the provisions of the Coastal Program regulations under which the proposed activity is excluded, and provide information that demonstrates compliance with the regulations. Within 30 days of such notification, BMR must prepare a set of findings based upon the same criteria that are used to evaluate permits for regulated activities. These findings are then provided to the party proposing the excluded activity as well as to the Commission. If the findings conclude that the proposed activity is not in compliance with the public policy of wetlands protection, then the project cannot go forward as proposed.[26] If the proposed project is begun despite negative findings by the Commission, enforcement action can be taken against the violator.[27]

From the above review, it would appear that when port authorities make decisions that affect coastal wetlands and would otherwise be subject to the permit process, they are bound to follow the policy of the

Wetlands Protection Law and the Coastal Program. Therefore, their control over the marine resources within their jurisdiction is inferior to the jurisdiction of BMR and the Commission.

However, if a local port authority does not share the coastal resource management philosophy embodied in the Coastal Program and fails to cooperate with positive coastal planning efforts, as is often the case, a tense political situation develops between State and local government, with BMR, the Commission and the Attorney General's Office being placed in the uncomfortable position of taking enforcement measures against the local port authority and/or county board of supervisors. In that instance, the courts may be called upon to interpret the intent of the legislature with respect to such policy and jurisdictional conflicts.

Conclusion and Recommendations

To adequately protect the marine resources upon which the economy of the coast is based, coastal resource managers must work together in implementing Mississippi's Wetlands Protection Law and Coastal Program. These laws represent the culmination of many years of hard work by people who recognized the increasing and often conflicting demands upon our coastal resources. The Wetlands Protection Law and Coastal Program were designed to provide a framework for decision-making and conflict resolution. However, as pointed out in the above discussion, apparently conflicting legislative mandates have created potential problems, particularly in the area of industrial development decision-making. To help remedy these inconsistencies, the following recommendations are made:

(1) The statement of public policy in section 49-27-3 of the Wetlands Protection Law should be more definitive. The exception for projects which serve "a higher public interest" is vague and should either be more fully explained or deleted.

(2) Section 49-27-7, which exempts certain activities and entities from permitting provisions of the Wetlands Protection Law, creates unnecessary confusion. This section should be amended to make it clear that this is a limited exemption from the formal permit application process only, and that the Commission still has the ultimate decision-making authority over whether the proposed activity itself will be allowed.

(3) Since one of the goals of the Wetlands Protection Law and Coastal Program provides for reasonable industrial expansion, SMA planning in industrialized areas such as already existing industrial parks and ports should be mandatory, rather than voluntary, with the Commission having ultimate authority over the development of these plans. They should continue to be created in consultation with the local governments, industries, etc., that are involved. However, the Commission needs to have the power to break a stalemate in the event that a consensus cannot be reached on an issue.

(4) The enabling legislation of port authorities and of industrial development commissions should be amended to reflect the policy of the Wetlands Protection Law and Coastal Program.

If the above recommendations were to be implemented, port authorities and other local coastal resource managers would be obligated to make their decisions within the framework of the comprehensive Wetlands Protection Law and Coastal Program, thus helping to prevent the adverse impacts on the coastal ecosystem which have been found to occur when parochial interests are made superior to a coordinated state plan.

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Footnotes

[1]Coastal Zone Management Act of 1972, 16 U.S.C. §1451 (1974 and Supp. 1975-1981).

[2]Mississippi Coastal Wetlands Protection Law, MISS. CODE ANN. §49-27-3 (Supp. 12 1982). "Coastal wetlands" are defined as "all publicly owned lands subject to the ebb and flow of the tide; which are below the watermark of ordinary high tide; all publicly owned accretions above the watermark of ordinary high tide and all publicly owned submerged water-bottoms below the watermark of ordinary high tide" and is interpreted to include the flora and fauna on and in the wetlands. Id.,§49-27-5(a), (b).

[3]MISSISSIPPI COASTAL PROGRAM (August, 1980).

[4]Mississippi Coastal Wetlands Protection Law, Supra note 2.

[5]Id., §49-27-9 through 57.

[6]MISSISSIPPI COASTAL PROGRAM, III-4 (August, 1980).

[7]MISS. CODE ANN. §49-27-5 (Supp. 12 1982).

[8]Id., §49-27-7 (h), (o), (p). (q), and (r).

[9]Id., §49-27-7.

[10]Id.

[11]Id., §57-16-6 (Supp. 1982); MISSISSIPPI COASTAL PROGRAM, 1-2 (August, 1980). The other goals are: (a) To protect, propogate, and

conserve the state's seafood and aquatic life in connection with the (revitalization of the seafood industry of the State of Mississippi. (b) To conserve the air and waters of the State, and to protect, maintain, and improve the quality thereof for public use, for propogation of wildlife, fish and aquatic life, and for domestic, agricultural, industrial, recreational, and other legitimate beneficial uses. (c) To put to beneficial use to the fullest extent of which they are capable the water resources of the State, and to prevent the waste, unreasonable use, or unreasonable method of use of water. (d) To preserve the State's historical and archaeological resources, to prevent their destruction, and to enhance these resources wherever possible. (e) To encourage the preservation of natural scentic qualities in the coastal area. (f) To assist local governments in the provision of public facilities services in a manner consistent with the coastal program. (g) To consider the national interest involved in planning for and in the siting of facilities in the coastal area. (h) To ensure the effective, coordinated implementation of public policy in the coastal area of Mississippi comprised of Hancock, Harrison and Jackson Counties.

[12]MISSISSIPPI COASTAL PROGRAM, VIII-39 through 53 (August, 1980).

[13]Id., VIII-47.

[14]Id., VIII-12, 13,14.

[15]Id., Chapter VI.

[16]Id., VI-2, 3.

[17]Id., VI-4.

[18]MISS. CODE ANN. §59-9-1 (1972).

[19]Id., §59-1-17 (1972).

[20]Id. These powers are referenced from MISS. CODE ANN. §59-19-15 (1972), "Powers and Duties of Authority or Commission," which in turn are referenced from MISS. CODE ANN. §59-7-129 (1972), "Duties of Port Commissions."

[21]Id., §59-9-21 (Supp. 1982).

[22]Id.

[23]16 U.S.C.A. §1451 (1974).

[24]Specific criteria are provided in Section VIII of the Coastal Program to determine which industry is to be considered "water dependent."

[25]MISS. CODE ANN. §49-27-7 (Supp. 12 1982).

[26]MISSISSIPPI COASTAL PROGRAM, VIII-18, 19 (August, 1980).

[27]Id., VII-37.

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CONSIDERATIONS IN THE DESIGN OF A NATIONAL WATER RESOURCES RESEARCH CENTER

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INTRODUCTION

In the fall of 1983, Congress appropriated funds in Public Law 98-181 for the conduct of two studies to be carried out under the auspices of the President's Council on Environmental Quality (CEQ). The studies were to assess the feasibility of establishing (1) a national center for water resources research and (2) a national clearinghouse for water resources information. The Chesapeake Research Consortium (CRC) was contracted by the CEQ to conduct the research.

The contract for the project required that the studies be conducted in two phases. In Phase I a number of alternative designs for each center would be proposed to the CEQ, and in Phase II three of these would be critiqued and analyzed in detail. Both Phase I and Phase II reports were widely circulated for public comment, and a number of public meetings were held by the CEQ to obtain further views. This paper summarizes the results of the water resources research portion of the CRC study; a companion paper by Maurice Lynch discusses the information clearinghouse issue.

BACKGROUND

The authorizing legislation for the study, sponsored by Senator Dennis DeConcini of Arizona, was very brief. It directed the CEQ to define and consider a national water resources research center and define and plan a national clearinghouse for water information. The rationale for Congress directing the CEQ to undertake these studies at this time is not clear, but it appears to be related to several factors.

First, it can be seen as a response to a recent report of the Office of Technology Assessment (1983) which addressed "the need for an interdisciplinary program of basic and applied research on arid/semiarid-water resources." The report suggested that Congress could establish a National Center for Water Resources Research to provide a coherent and coordinated mechanism for the Nation's university research programs in water resources and water resource management for problem-solving and policy making. The center would (1) undertake an interdisciplinary program of basic and applied research; (2) develop sophisticated research facilities on a scale often not affordable by single universities; (3) develop and test conventional and emerging technologies; and (4) serve as an objective nonpartisan source of information for Congress and a link to public agencies, water users and the private sector for application of research findings.

The impetus for the study can also be traced to several earlier reports by the U.S. General Accounting Office, including one on water issues facing the Nation (1982) and another on the need to provide a better focus on water-related research activities (1981). The latter report concluded in part that better coordination of the nation's water research activities was required.

Finally, the National Water Alliance has been actively promoting a national water research center and clearinghouse. The Alliance, formed in 1983, was organized by six members of Congress (including Senator DeConcini) and is intended to provide a forum for debate and research on water problems. One of its program goals is "to establish the framework for a multi-disciplinary water research program." (National Water Alliance, 1984).

APPROACH

In the first phase of the study it was required that existing water resources research programs be examined and that literature be reviewed which pertained to the planning, conduct, management and coordination of water research in a national context. The purpose of this analysis was to identify needs in water research which could be addressed by a national center. In addition, interviews were conducted with federal and state agency officials, state water institute directors, persons in the university water research community, and private voluntary and professional organizations in order to obtain their views on water research needs. On the basis of these interviews and the literature review, eight mission statements were proposed to the CEQ for institutions which addressed various needs, or combination of needs, identified in water research. The CEQ circulated this report for comment and, on the basis of such comments, selected three for detailed analysis in Phase II of the study. In the second phase, for each of the three options or missions, institutional arrangements were designed, implementation requirements and operational characteristics specified, and a critical review undertaken. A preliminary report of the findings was widely circulated by the CEQ for comment in the water research community, and the final report reflected, to the extent possible, many of these comments.

THE WATER RESOURCES RESEARCH SETTING

In order to develop a perspective on the role of a new water research institution, the study sought to gain an understanding of the scope of current research efforts and trends in the field over the past several decades. Several findings emerged which influenced our approach to the design of a national center.

The first is that a sizeable water research effort already exists in federal and state agencies, the state water institutes, the universities and the private sector. At least 27 federal agencies conduct water research in fulfilling their missions, and many states have significant water resource programs. The National Research Council Report (1981) indicated that federal agency expenditures on water research were about $380 million annually. While this level of funding has dropped somewhat in recent years, it is likely that expenditures in all sectors (federal, state and private) are well in excess of $400 million annually and have totalled nearly $2 billion over the past decade. For this reason, proposals for major new initiatives must be weighed against the existing array of water research programs.

A second factor is that water research is not a new and emerging field but one that is relatively mature. Although such a statement is difficult to substantiate quantitatively, there is some evidence to support this contention. One indicator is the number of professional journals devoted to various aspects of water. The list of journals abstracted by the Water Resources Scientific Information Center contains over 100 published in the United States that directly deal with water and many others that contain water-related articles. Another is that a generation of persons who are now at or near retirement have spent their entire professional careers in water research. Over the past three decades a number of persons have achieved major scientific stature as a result of their water research activities. Finally, the field has been large enough, and of such significance, that it has produced many efforts to rationalize the research planning and management process to better focus on national needs. The management, conduct and organization of water research have been the subject of numerous studies and reports, and while many of them have been critical of the way in which the national water research agenda has been organized, the attention devoted to the topic suggests a relatively well-developed field. This is not to suggest that no significant water research issues remain, only that the field has developed a substantial body of information, many organizations and institutions already exist for the conduct of research, and that under these circumstances the justification for a new organization is more difficult than it might have been 25 years ago.

A third factor has to do with the identification of national water research needs and how they are being met through federal and state programs. Starting with the Senate Select Committee Report in 1961 and the Committee on Water Resources Research Report in 1966, a number of studies have identified needs and priorities in national water resources research. The needs identified have changed somewhat over the years, but there is a high degree of similarity in the various studies. Examination of the 1981 Office of Water Research and

Technology Report on the Five Year Water Research Priorities of the States shows that most of these same national issues are also important at the State level. Moreover, the great majority of these needs are receiving active attention in the water research community. According to the 1981 National Research Council review of the five-year federal water research plan, only one of thirty-one priority areas (institutional arrangements for water allocation) was not being addressed to some degree by one or more agencies.

A final factor that has influenced our analysis is the trend that appears to be developing in water planning, development and research. The traditional federal water resource development program of the post World War II years is fading, and primary responsibility for future water resources development and management is likely to be shifted to state and local governments (Caulfield, 1984). Future water issues appear to be less involved with water development and more concerned with subjects such as conservation, use and reallocation of water, and water quality. Such issues have substantial social, legal, economic, and institutional dimensions and thus it follows that research in these areas ought to receive higher priority than it has in the past. The National Research Council study reached a similar conclusion, and we believe that their findings continue to be valid.

NEEDS IN WATER RESOURCES RESEARCH

The design of this study required the identification of needs which a national water research center could address. As noted earlier, such needs were identified through literature review and by interviewing a number of persons in the water research user community. The results of this research are as follows:

A number of reports have addressed various aspects of national water resources research. (See for example: Senate Select Committee, 1961; Federal Council for Science and Technology, 1966; National Water Commission, 1972; Office of Water Research and Technology, 1977; National Research Council, 1981; and The General Accounting Office, 1981). Much of this literature has focused on the need for coordinating or managing the water research activities of federal agencies. In general, these reports have stated the importance of water to the nation's development or well being and that research is needed to provide a sound basis for management of water. They have also observed that existing federal research efforts did not exhibit effective planning, management and coordination, and were fragmented among many agencies. In order to improve this situation, the studies developed systems for categorizing research so that interagency programs could be compared. Proposed statements of national research needs were compared with existing programs so that gaps or redundancies could be identified and various management approaches or institutional arrangements were recommended for improving the overall research process. Some organizations were established to coordinate water research and planning, including the Committee on Water Resources Research (COWRR) under the Office of Science and Technology, the Office of Water Research and Technology (OWRT) in the Department of the Interior, and the Water Resources Council. None of these were able to sustain its planning and coordination activities over a significant period of time. However, a need for this function continues to be perceived as pointed out in the 1983 OTA report, the two General Accounting Office studies in 1981, the 1981 Report of the National Research Council, the February 1984 meeting of the National Water Alliance, and in interviews conducted for this study.

A second general need that was stated is for the augmentation of existing federal agency programs with funds for a non-mission oriented national research program. This need is based on the recognition of two factors, that current research efforts are largely directed towards agency-missions and, that the funding base for federal water research is relatively small in comparison with present and future needs for effective water management. Two approaches have been suggested. The first is for a research allocation-type extramural funding program similar to that formerly administered by the OWRT in the 1970s. The other is for a focused research program directed at a particular region (e.g., agricultural needs in arid lands) or regions. In the latter case a physical facility or network of facilities would be constructed and staffed to conduct this research. The OTA study has proposed such a research center in the West, and others in different geographical regions have been suggested.

A third need expressed in the course of this study was for water resources information. This topic has seldom appeared in the literature on national water research needs, although there clearly has been a continuing interest in information and technology transfer. However, some federal agency representatives, many of the state water officials and all of the private organizations interviewed for this study believed that although water research was important, a higher priority should be given to the national level to improving the availability of, and access to, existing water information. A few went further and indicated that this topic should be the primary focus for this study.

Since the term "information" covers such a wide range of topics, it is not clear what specific needs were being stated by those concerned with this topic. For some, synthesized, issue-specific information was desired. For others, particularly state and local officials, the problem is to find out what information is available to help them address a particular issue and to obtain assistance in the interpretation of the data. In both instances, a need was expressed for some entity (or network) that would be able to state whether or not relevant water information was available, where it was available, in what form, and how it could be obtained or accessed.

Finally, a significant number of persons interviewed during the study stated that no compelling need existed for a new national water research center. Persons with this point of view observed the extreme difficulty of developing and sustaining an effective coordinating mechanism for federal research. They expressed the opinion that major gaps in existing programs do not exist in terms of important national water research needs, although they recognized that agency programs do not always address such needs in the most timely manner possible and may not be adequate to the needs.

In summary, several general needs in water resources research have appeared for this study. They include:

1) Coordinating federal research programs;

2) Identifying national water research goals and needs and assessing progress being made in addressing these needs;

3) Augmenting existing federal research through a program of extramural research oriented towards the university and non-federal research sector;

4) Establishing one or more focused interdisciplinary water research institutes;

5) Providing for a national water information program; and

6) Recognizing that the existing array of agencies and institutions provides a comprehensive and reasonably effective program in water research which should be maintained.

Each of these needs were proposed to CEQ in the form of missions for institutions which could be established to address such needs. Several institutions with combined functions were also proposed. After receiving extensive public comment on the CRC analysis, the CEQ directed the CRC to examine in detail the following options:

1) Maintain the existing array of water research programs but identify incremental changes which could be made to address some of the deficiencies in these programs;

2) Propose a national water research center that would identify research needs and priorities and provide funds on an extramural, competitive basis to address these needs; and

3) Propose a national water research institute which would conduct interdisciplinary studies of major water issues facing the nation.

These will be discussed further in the section to follow. It should be noted that the information need identified was addressed in the clearinghouse section of this study.

ANALYSIS OF OPTIONS FOR A NATIONAL WATER RESOURCES RESEARCH CENTER

In this section the three options selected for study by the CEQ will be analyzed in terms of their underlying rationale, and institutional arrangements will be proposed for each.

OPTION 1: IMPROVING EXISTING INSTITUTIONAL ARRANGEMENTS

This option does not directly address the establishment of a national water research center. Instead, it examines the existing array of water research programs in order to determine how marginal improvements might be made to improve the timeliness and effectiveness of research, to better integrate findings, to provide for periodic review of programs and priorities and to find ways in which the fragmented programs of the federal government could be made more effective.

RATIONALE FOR MAINTAINING EXISTING PROGRAMS

It was stated earlier in this report that there is some sentiment in the water research community for the proposition that the existing system of largely mission-oriented research has been successful in addressing important national water research needs and, within the limits of available funding, in resolving these needs. Proponents of this view argue that attempts to coordinate or manage this complex and interrelated system are unwarranted and are likely to be unproductive because they do not recognize the degree of voluntary coordination and cooperation that already exists. Moreover, existing agency programs are highly responsive to constituent needs, and attempts to alter such arrangements would jeopardize the conduct of agency missions.

This point of view is based on several arguments. The first is that major gaps in past and current research programs do not exist relative to recent statements of national needs. As mentioned previously, the National Research Council report in 1981 found that only one of 31 priority research topics was apparently not then being addressed by one or more federal agency programs. The extent to which each topic was being adequately (or redundantly) addressed could not be determined. Our analysis of current federal agency programs, matched against the same priority list, came to the same conclusion.

Secondly, it is argued that redundancy, duplication, overlap and fragmentation have positive value in a research network. For example, redundancy can be used as a device for suppressing error. Overlap and duplication may provide backup systems in the event that one research effort fails or is terminated. In this sense, the goals of coordination may be at odds with the positive aspects of the current situation. Moreover, the argument for coordination overlooks the fact that numerous informal or *ad hoc* mechanisms for interagency coordination do exist (e.g., the task force on acid rain). A substantial degree of coordination also occurs at the level of individual scientists or laboratories through such means as peer review of proposals and publications, external review committees, and professional conferences and seminars.

The third argument for existing arrangements recognizes the diverse nature of federal agency water research programs, their mission orientation, and the fact that a number of different Congressional committees are involved in the budgeting process for water research. It is argued that unless all federal water research was located in one or two agencies that reported to one or two Congressional committees, it would not be possible to achieve a coordinated effort.

Finally, at a more practical level, it has been pointed out that all efforts to provide a central coordinating mechanism have ultimately failed, event though strong presidential leadership or interest (under Kennedy, Johnson and Carter) was evidenced. In addition, the 1978 Water Resources Research and Development Act specifically called upon the President to achieve coordination of water research programs, but the central mechanism for providing such coordination (OWRT) has since been abolished, and in the 1984 Water Resources Research Act (Public Law 98-242) the mandate for coordination has been eliminated altogether.

PROPOSED IMPROVEMENTS TO EXISTING ARRANGEMENTS

Most of the deficiencies perceived to be associated with federal water research efforts can be attributed to the limitations of multiple agency programs and diverse research efforts which are dealt with by a variety of Congressional committees and constituents. Although there has been a sustained effort to create centralized research coordinating mechanisms to overcome these limitations, all of these have failed to endure. The relevant question for this option, therefore, is whether any incremental improvements in the existing federal water resources research program could be proposed and would be able to be implemented.

We propose that a major weakness in the existing arrangement is the fact that, at any given time, it is impossible to: (1) establish in any coherent way the content and scope of the overall national water research effort; (2) determine its progress over time; or (3) ascertain its future directions. We have observed in this study, as did the National Research Council in 1981, that it is exceedingly difficult to assess the scope and nature of federal water research on an ad hoc basis. The programs involved are complex and diverse. A listing of projects being conducted by individual investigators or agencies provides no useful information on the historical development of research agenda nor the factors that have led to their design. Without such information being available on a continuing basis, any assessment of the national water research effort is bound to be superficial and unproductive. More important, neither the Congress, the Office of Management and Budget, the general public, nor the agencies themselves have a summary of all the information needed to make such judgments. It is likely that this state of affairs is at least partially responsible for the concern expressed over water research in the Office of Technology Assessment report and by the National Water Alliance.

We suggest, therefore, that a need exists for information which describes the scope and nature of the federal water research effort on a continuing basis and which can periodically assess the progress being made in this effort towards achieving goals for water research in the national interest. One way in which this could be accomplished with only a modest change in current institutional arrangements would be by the establishment of a National Advisory Committee on Water Resources Research. The Committee would be responsible for:

1) Maintaining a comprehensive nationwide, and up-to-date description of the many water research programs;

2) Disseminating information about, and periodically reporting on, national water research programs; and

3) Providing an information base which can be used to periodically renew water research activities in the light of national water research needs and goals.

In terms of improvements to the existing institutional arrangements, we believe that the committee could accomplish the following:

1) Establish a single national focus for water resource research.

2) Provide an information base for the Congress and the OMB for understanding the total national water resources research agenda.

3) Assist the water research agencies by making information available on the current status and future plans of other agency programs.

4) Provide information that could be used for periodic reviews of national water research programs and plans.

5) Facilitate the flow of information within the water research community.

OPTION 2: EXTRAMURAL RESEARCH

Introduction

In this option, the CRC was requested to critique a National Center that would establish research needs and priorities and provide funds on a competitive basis to proposals which address these priorities. In developing this critique, several general conclusions were reached that influenced our approach to such a center. They are:

1. Budgets of some agency water research programs have declined in recent years. In discussions with various agency personnel about potential research areas suitable for extramural funding, it was often pointed out that such subjects could be effectively addressed by the agencies if they had the necessary funds. However, as indicated in Option 1, it can be inferred from the passage of PL 98-242 that augumented funding of water research will be directed towards university-oriented research. If mission-oriented agency programs do not receive continuing or increased support this may represent an incremental shift in national water research policy.

2. PL 98-242 authorizes an extramural research program in the Department of the Interior (DOI). If fully funded at authorized levels, the annual program budget would be $36 million for research, although $10 million of this amount is to be allocated directly to the state water research institutes. We examined a number of arguments for proposing a separate extramural program outside of the DOI but it was difficult to distinguish between the two programs and to justify the additional funds that would be required by a separate non-DOI program. Therefore, we have designed what we believe would represent an "ideal" extramural institution and then indicated the kinds of changes that would be required in PL 98-242 (or actions by the Secretary of Interior) to make such an "ideal" institution viable in the context of that legislation. We are not implying here that DOI is necessarily the best "home" for an extramural national research program, only that at this time it seems preferable to the other alternatives we considered.

Rationale for Extramural Research

As indicated above, it can be argued that augmentation of federal water resources research could legitimately be focused on the mission-oriented agency programs. However we see the rationale for an extramural program to be as follows. Such a program would:

1) Marshall external expertise otherwise unavailable in existing programs;

2) Quickly identify, and respond to emerging problems;

3) Address topical issues that overlap or cut across agency jurisdictions;

4) Fund fundamental or basic research questions not being addressed;

5) Fund short-term programs where a rapid expansion and contraction of personnel would be required; and

6) Target complex interdisciplinary issues for long-term, sustained support.

The center which administers the extramural program should define the basic characteristics of the research it intends to solicit and support. In reaching that definition the following priorities should be used:

1) Research funded should be in the "national interest," and criteria for defining such a program should be developed as one of the first actions of the board which governs the center;

2) Research on the social, legal, institutional and economic issues associated with the allocation and use of water should receive a high priority in the agenda of the center;

3) Priority should be given to truly interdisciplinary research efforts;

4) The center should identify and be prepared to support areas of high priority basic research which require long-term, sustained support at one or more existing institutions;

5) Except as noted in No. 6 below, funding should be directed to investigators in non-federal institutions (universities, state researchers and the private sector); and

6) Consideration should be given to the occasional support of federal agency programs where supplemental funding would be needed to investigate or respond to an important short-term research opportunity.

The Center and Public Law 98-242

As indicated in the Introduction to this option, it is our judgement that the Center cannot realistically be considered apart from PL 98-242. The legislation provides for extramural funding of water research and maintains the state water institute program intact. Proposing an entirely new Center would result in competition with, and duplication of, the 98-242 program. It would also be counter to the strong congressional mandate expressed in the legislation which was only recently passed over the President's veto. An alternative would be to move PL 98-242 from the Department of Interior (DOI), establish it elsewhere as a independent entity, and suggest new legislation to reflect more closely the "ideal" Center described above. This has some merit conceptually because the Center would then be independent of a mission agency or department. There are, however, several drawbacks. First, the state institutes and the water research community in general appear to be reasonably well satisfied with the relationships established over several decades with DOI. It is expected that they would oppose the siting of the Center in a different institutional setting. Second, we were not able to identify another organizational affiliation that would be preferable. The Office of Science and Technology Policy, the CEQ and the National Science Foundation were considered but each had significant limitations for administering the kinds of programs specified in PL 98-242. Finally, in our review of the projects funded by the old OWRT and more recently by the Bureau of Reclamation, we were unable to discern a DOI "bias" in the range of issues addressed.

We propose therefore that the entire program of research as stated in PL 98-242 be considered as a National Water Resources Research Center within the Department of the Interior. The Center would then encompass the substantive provisions of this legislation, particularly Sections 104, 105 and 106 which include the state water research institutes, the focused extramural matching grant program and the technology development program.

We suggest that Section 104 be maintained in essentially its current form and funding level. Section 105 should have the matching requirements removed to reflect the fact that research funded would be in the national interest even though the application or incidence of that research would be at the regional, state or local level. The criteria for the kinds of research that the Center intends to solicit and support in Section 105 should be those listed in the Introduction to this option. This section should be funded at the authorized level of $20 million. Section 106 should be included in the Center in its present form and at its authorized funding level.

PL 98-242 does not contain specific provisions for a Board. We strongly believe that a broad-based agenda-setting Board is crucial to the operation of such an extramural program and that the Board's activities should be coupled to the Center's research functions. Such a linkage would enhance the reality and the perception that the Center's research was focused on priority national issues. In addition, the Board would tend to enhance the Center's constituent base and to that extent it would assist in maintaining a greater degree of stability and permanence. Without such a Board, we doubt that the

Center would represent a significant improvement over current institutional arrangements even though new research initiatives would be undertaken. It is our interpretation that although PL 98-242 does not explicitly provide for such a Board, nothing in the legislation would appear to prevent its establishment. We propose that the Secretary of the Interior appoint a broadly-based Board representing the Congress; local, state and federal agencies; academic institutions and society at large on a regional basis.

OPTION 3: FOCUSED RESEARCH INSTITUTE

Introduction

In this option, CRC was directed to examine the feasibility of establishing one or more institutes focused on broad national needs in water research. In considering such institutes the CRC was to document glaring research needs not covered by existing research programs for which the research interests of several entities can be focused at a single location, or at which significant fiscal savings could result from sharing expensive equipment.

In addressing this option we sought to identify subject matter areas for which an institute appeared to be the most effective research strategy. In order to accomplish this, we first asked our consultant advisors to the project to develop a list of water research issues which represented important national needs. This list of national research needs, supplemented by lists proposed in previous studies of water research, was reviewed in order to determine whether issues could be stated for which a focused institute model would be an appropriate approach. In conducting that item-by-item review, we delineated two substantially different versions of a potential water research institute. One was a "research laboratory," site-specific, facility which would include sophisticated and expensive equipment and would be staffed by an interdisciplinary group of physical scientists (i.e. hydrologists, geologists, physicists). The research of this laboratory could be focused on modeling complex groundwater systems.

The second version, which we called the "research institute," emerged as we examined the content and characteristics of the items on the list of national research needs. This entity would not be primarily oriented toward doing basic science on water resources. Instead, it would be staffed by an interdisciplinary group including not only various types of physical scientists but also engineers, economists, organizational and institutional researchers, and other social scientists.

The array of national water research needs was then examined to identify those which "required" a national or regional research lab or which required a research institute. Thus, according the CEQ's directive, to be included for either version, an item has to be "a glaring research need not presently covered by (existing) major research programs." An item also had to be such that it would be much better addressed (or more cost-effectively addressed) by being "focused at a single location," than by being researched at a number of different places. Lastly, in the case of the "research lab," to be selected an item had to involve "expensive research equipment" or facilities.

In reviewing the list of items, many were identified (e.g. groundwater contamination, water reuse) that were serious problems and appeared to require scientific research and substantial additional financial resources to support that research. In several such cases it was also clear that the creation of a research center focusing on that subject would result in desirable interdisciplinary synergy. Furthermore, a new center might well provide the visibility and ability to acquire financial resources that would foster more rapid advancement of knowledge in that field. However, the question posed by this alternative was not whether the subject area required additional research and funding. Rather, the issue was whether a new organizational structure, either lab or institute, was needed to answer the research need. It was concluded that, in most cases, reasonably competent organizations, federal or others, already existed that were working on the problem. These items, were not selected as appropriate for a new lab or institute. A similar analysis using the same criteria was conducted of the research needs identified in the 1981 National Research Council study.

The item-by-item analyses led to two conclusions: 1) no clear need exists for a new research laboratory, although existing facilities, programs and organizations may well need some expansion or additional funding; and 2) a new research institute might be justified by the perceived need for synthesis of existing research and for increased emphasis on interdisciplinary and institutional research.

To test further the validity of the first conclusion, we discussed with a number of investigators various aspects of the topic of groundwater research, which had been suggested to us as a focus for study by a permanent water research center. We found little support for the research facility approach because of the diversity of groundwater issues and because greater efficiencies could be achieved by targeting groundwater research in existing institutions or programs.

As previously indicated, most of the water research subject areas that have been identified as important or of priority are already being addressed to some extent by existing programs. Also, none were found for which a new facility or laboratory seemed the most cost effective and scientifically defensible strategy. There may be water research subject areas which would profit from enhanced funding. However, a better approach would be to target these for support with an extramural program (as in Option 2) with funds directed to one or more existing institutions. Alternatively, enhanced funding of existing mission agency programs could accomplish the same purpose in certain cases.

Although we also were unable to identify particular subject matter for which an institute was clearly the most effective approach to research, there was agreement within our consultants group and support elsewhere in the water research community for an entity that would 1) synthesize research results and their implications and 2) conduct interdisciplinary analyses of water issues of national significance that involve institutional, social and legal issues. Such analyses must be grounded in science and therefore such disciplines should be represented in the staff. But the "problem-solving and policy" oriented focus of such analyses also requires the involvement of experts in law, engineering, the social sciences and the management disciplines.

This option builds on a proposal in the OTA report which apparently was partly responsible for the authorization of this study. That report asserted, "There is a lack of a national coherence and synthesis of university water-related research" and cited "arid/semi-arid-water resources" as a case in point. The OTA report made reference to the National Center for Atmospheric Research (NCAR) university consortium model of atmospheric research and proposed that "Congress could establish a National Center for Water Resources Research to provide a coherent and coordinated mechanism for the Nation's university research programs in water resources and water resource management for problem-solving and policymaking." There is some sentiment in the water resources research community for such a center as well as a belief that Congress would be receptive to the establishment of such a center by virtue of its funding this study.

This option builds on that concept, expanding and modifying it. Like this OTA proposal, it includes the synthesizing function and the interdisciplinary orientation. Furthermore, it would most probably be organized in the form of a university consortium, along the lines of NCAR. Like NCAR, the institute would perform multi-disciplinary research on generic problems not addressed by agency-oriented programs and cross-cutting both organizational and political boundaries. It too, would be "insulated from short-term political" and "problem-of-the-moment" pressures, and would be an "objective, non-partisan and continuing source" of information.

However, this option expands the scope of concern from university-related water research alone to encompass all federally-funded water resources research. Secondly, it modifies the subject focus. The OTA report proposes an "interdisciplinary program of <u>basic</u> and <u>applied</u> research on water resource and water-resource management, including strong programs in the natural sciences, engineering, and social sciences, such as resource economics and law as they pertain to water-resources programs." While the mix of expertise envisioned by this option is similar to that in the OTA report, the focus would be on application rather than basic science. The Center would not be a laboratory for "site-specific research" nor would it have "advanced and sophisticated research facilities."

SUMMARY

In conducting this study it was observed that water resources research is a mature field with large and diverse existing programs which are fragmented among a number of agencies, organizations and institutions. The rationale for creating a new center had to recognize the nature of this existing situation. In this context, three options for a National Water Resources Research Center were proposed. The options included incremental changes to improve the coherence of existing programs; a center to direct and support extramural research; and an institute to study interdisciplinary water research issues. Each option is intended to address a stated water research need. The options proposed are not mutually exclusive. Each research center meets a prescribed need and thus sufficient justification exists for all three to be established simultaneously. Research and information functions could also be combined within a single organizational entity.

During the course of the study a number of persons in the water resources research community were interviewed about their views on the proposed centers and others offered written comments to the CEQ during and after public meetings on the study. It was found that there was little agreement within the research community on the need to be met by a new center or the preferred institutional arrangement. This does not imply that the proposed research centers are without some public support, only that no apparent consensus exists on any one option.

Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ. Copyright by The Coastal Society 1985.

TOWARDS DESIGN OF A NATIONAL WATER RESOURCES INFORMATION CLEARINGHOUSE[1]

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- **What is water resources information?**
- **Who needs water resources information?**
- **Where do we find water resources information?**
- **Are our present water resources information sources meeting the need?**
- **How can we improve our water resources information system?**

These and a series of related questions were addressed during a recent study conducted by the Chesapeake Research Consortium (CRC) under contract to the Council on Environmental Quality (CEQ). Sullivan (1985) describes the background of this study in a report on a parallel effort towards developing a design for a National Water Resources Research Center.

The study was conducted in two phases. Phase I (CRC, 1984a) reviewed the present status of water resource information services; attempted to define the needs for water resources information; and developed a number of mission statements (more properly functions) of alternative institutions to meet the needs. Phase II (CRC, 1984b) developed institutional arrangements, organizational characteristics and a critical review of three options selected by CEQ after public hearings and consultation with government, academic and commercial institutions or agencies with interests in water resources information.

1. Contribution # 1253 from Virginia Institute of Marine Science.

What is Water Resources Information?

The phase 1 study identified more than 30 agencies with water related missions. To many individuals in these agencies, the concept of water resources or water resources information was limited to the scope of their agency mission. The problem of defining water resources information is compounded at the national level in that no single committee in either House of Congress has principal or sole responsibility for "water" or "water resources".

In order to satisfy the many constituencies claiming affinity with the water resource community, we considered water resources to include ground water, surface water and estuarine waters. Water resources information includes atmospheric sources (e.g. rain and snowfall), water characteristics (e.g. data on amount, location, flow, quality, movement and pathways), usage (e.g. consumption and discharge), and institutional factors (e.g. water rights and regulatory controls). Water resources information needs include both data (raw facts or observations often characterized by numerics or quantification) and documents (writings, maps, charts, books, journals, films etc. which summarize, evaluate, explain, interpret or present knowledge).

Who Needs Water Resources Information?

Water resources information users can be broadly characterized into two groups.

1. Sophisticated users are usually professionals that have the technical capability to synthesize information obtained from a variety of sources in the context of a specific issue. Scientists, engineers and water resource planners working in their field usually fall within this group.

2. Unsophisticated and peripheral users are those who lack either general or specific skills to analyze technical information in a specific context or who lack the knowledge about availability of appropriate information. Legislators and their staffs, local officials, general planners, public interest groups, concerned citizens and scientists and engineers working outside of their area of expertise may be included in this category.

The distinctions between these categories of users is not precise and is to a large extent based upon their familiarity with the sources of specific information. A routine user of the U.S. Geological Survey's (USGS) WATSTORE (National Water Data Storage and Retrieval System) and NAWDEX (National Water Data Exchange) may be sophisticated with respect to the use of these systems but unfamiliar with or unaware of coastal, estuarine or climatological data available though systems maintained by the National Oceanic and Atmospheric Administration (NOAA).

Where Do We Find Water Resources Information?

The fiscal year 1985 Federal Plan for water data acquisition (OWDC, 1983) includes 28 federal agencies with water related missions. In addition there are several federal agencies with major data collection efforts important to water resources such as the National Marine Fisheries Service and the National Environmental Satellite, Data and Information Service (NESDIS) which are not included in this plan.

The majority of federal water resource related data is held in three agencies. WATSTORE has the most extensive collection of hydrologic and water quantity data, the Environmental Protection Agency's (EPA) STORET system has the most water quality data and NESDIS's National Oceanographic Data Center has the most marine and estuarine water resources data. Many state and local agencies and universities maintain extensive water related files, much in machine readable form. Many of these are listed and described in either NAWDEX or NESDIS's National Environmental Data Referral System (NEDRES).

Efforts to collect and/or catalog documents related directly to water resources are not as extensive as data storage efforts. The principal effort related to water resources documents is Selected Water Resources Abstracts prepared by USGS's Water Resources Scientific Information Center (WRSIC). Other federal abstracting or indexing entities such as the Department of Commerce's National Technical Information System (NTIS) and the Department of Agriculture's AGRICOLA do not specifically abstract or catalog with water resources in mind.

Finally, the National Referral Center maintained by the Library of Congress listed over 1100 water related information sources, many of which are multiple information bases.

Are Our Present Water Resources Information Sources Meeting The Need?

In trying to determine whether the present sources of water resources information are meeting the needs of individuals or organizations for water resources information one must always be mindful of Finagle's Law (Doyel, 1978):

1. The information you have is not what you want.
2. The information you want is not what you need.
3. The information you need is not available.

With the possible exception of institutional information, no major information gaps were identified during this study. In fact, the major complaint from several sources was not lack of information but a plethora of information, much of it unsynthesized from the perspective of the user.

Sophisticated users (working in their area of expertise) are usually able to meet their information needs (principally data) within the present systems. The major complaint is that they occasionally need to go to a number of different data bases or systems for relevant data and these may not be compatible with each other.

Unsophisticated users are usually not as concerned with data as they are with documents that synthesize or evaluate information. Many potential users are unfamiliar with specific information sources and are frequently frustrated in their attempts to obtain information.

No single water resources information source meets the needs of all individuals or organizations dealing with water resources.

How can we improve our Water Resources Information System?

At the present time, there does not appear to be a compelling need to create or establish new water resource data or document oriented information files at the national level. It is apparent, however, that there are a number of ways to facilitate access to or awareness of present information resources, and that by so doing a number of identified needs can be met.

Three options to improve the present system of delivery of water resources information were developed during Phase II of this study. These were:

1) specific recommendations for improving current institutional arrangements;

2) a referral center to serve as an initial point of access where persons could go to begin the search for water resources information (both documents and data) and obtain limited bibliographies;

3) a national and state clearinghouse system with regional centers in those areas with compelling need and a common bond among states, to obtain information for clients, provide information synopses and analyses of water resource issues, and develop a statement of research needs based upon requests to the clearinghouses.

The distinction between a referral center and a clearinghouse is:

- a referral center points or guides seekers of information to appropriate sources to meet their information needs (it does not provide the actual data or documents needed);

- a clearinghouse on the other hand, whenever possible, actually obtains the specific information required by information seekers and provides it to them.

Most clearinghouses perform this function by collecting and archiving information in their area of specialization on a continuing basis. In the water information area, however, there are so many established information bases, that attempting to develop a single all-encompassing water information base is not practical. Fortunately advances in computer communication technology, in particular, on-line transfer of text and data, obviate the need for a clearinghouse to actually collect and archive data itself in order to be effective.

Each of the three options can be perceived as a way to address the problem of access or awareness to a different degree. Specific recommendations for improving current institutional arrangements primarily address problems of coordination, comparability, and lack of resources (personnel and/or funds) within components of the present system. Although the primary effect of these recommendations will be to assist the present system users (sophisticated) by upgrading present capabilities, they will also provide increased opportunity for unsophisticated or peripheral users to become aware of information resources.

Establishment of a National Water Information Referral Center would enable unsophisticated and peripheral users to gain awareness of water resources information sources and to obtain information on how to access these systems. A limited bibliographic capability would provide some additional services for those users desiring or requiring more focused information on an issue. It does not, however, provide either group of users with syntheses or analyses of information.

The third option, a National/State Clearinghouse System, supplemented by appropriate regional clearinghouses, would facilitate information dissemination and use by providing the capability to extract appropriate information from numerous information sources. The research needs assessment function would also provide guidance to policy and budget personnel on research needs as a function of questions that cannot be answered with extant information. A variation in which the National Water Information Clearinghouse is supported by a number of disciplinary or subject focused Centers of Competence is also viable. Water problems, however, usually require an interdisciplinary approach and are site specific. In view of this, geographic focus for a water information clearinghouse is considered more appropriate. The capability under this option of providing periodic summaries of water resources information and the status of water resource problems at various levels, and the capability of providing reports on specific issues upon request respond directly to the expressed needs of many of the unsophisticated users.

Most important, the third option provides water resources information at the level most appropriate for its application i.e., information relevant for local or state issues would be provided by the state clearinghouses, information for national issues would be provided by the national clearinghouse, and in regions where there is a compelling need and a common bond among states (such as the Chesapeake Bay or Great Lakes) regionally focused information would be provided by a regional clearinghouse.

Improving current institutional arrangements would involve a number of specific actions. These are:

1. Revise OMB Circular A-67 (EOP, 1964) which presently places the responsibility for coordination of water data in the Department of Interior (accomplished by the Office of Water Data Coordination, USGS) to reflect the responsibility of NOAA (marine, coastal and atmosphere) and EPA (water quality) in the ares of water resources information aquisition, storage and dissemination.

2. Provide improved computer communication (automatic switching capability) between EPA's STORET, USGS's NAWDEX and NESDIS's NEDRES so that users with access to one system can access the information in the others. (NAWDEX users can now access STORET information.)

3. Provide additional funding to WRSIC to reestablish a number (5 recommended) of Centers of Competence in issues of present or emerging priorities. The centers would have the responsibility of abstracting reports and preparing annual state-of-the-art and issue papers in their area of competence.

4. Establish a water research information system dealing with current research-in-progress within WRSIC to fill the gap in research-in-progress tracking created by the abolishment of the Smithsonian Science Information Exchange in 1981.

5. Add water resources information specialists to the staff of the Library of Congress's National Referral Center (NRC) to provide focused collection on water resources and modernize NRC's software to allow full text searching and provide greater access to NRC's files through arrangements with private on-line information vendors.

6. Add water research specialists to the staff of the Congressional Research Service to deal specifically with water issues.

The major advantage of a National Water Information Referral Center would be that it would provide a marked improvement in the present system for locating water resources information. Since the Center would not be bound by a single water mission, it would be free to refer to information services over the full spectrum of water issues. The center would also be in a unique position to identify those information needs that are not being met by the existing system because the subject area may fall on the periphery or outside of an agency's mission.

This option would remedy the lack of a single point of access for water information. This advantage far outweighs the slight disadvantage of duplicating some of the referral functions of the existing water oriented information systems such as NEDRES and NAWDEX. The concentration of the center in the area of water would provide more focused and appropriate referral than is possible from a general referral center such as The National Referral Center.

A major advantage of the National, Regional and State Water Information Clearinghouse System over the referral center option is that it provides true one stop shopping for clients. Under the present system, a user normally seeks information from only one or perhaps a limited number of sources. Clients often wonder whether this information is complete and, therefore, adequate for their needs. The clearinghouse system would assure users that they have all the relevant information pertaining to a given issue. This feature would be an asset to both sophisticated and unsophisticated users, but would probably benefit the unsophisticated user more.

The provision for services at the state and regional levels provides information resources at the levels at which most water issues arise and are resolved. Clearinghouse personnel at these levels should quickly develop a knowledge of and sensitivity to issues at their level which would make them very valuable resources for managers. With information resource personnel functioning at each level, information should seldom "fall through the cracks" and information provided should be relevant to the issue driving the inquiry.

Extreme care must be exercised in establishing state level clearinghouses to ensure that they do not conflict with present effective water information activities. The probability of interfering with existing systems on the regional level is not as great since a criterion for establishing a regional clearinghouse is recognition by the states that regional water issues exist that cannot be resolved by individual state efforts.

SUMMARY

One could view each of the suggested options as falling on a gradient of information service activities beginning with the present system of independent, unconnected and relatively uncoordinated information agencies and ending with the full service organization embodied in the one stop National Water Information Clearinghouse. The first option proposes a number of relatively low cost modifications to the present system to improve coordination and service. A next logical step is to establish an organization which identifies all components of the present information infrastructure and advises users unfamiliar with the full range of this infrastructure as to the appropriate place to go for their information (a referral center). It is not too big a step from telling someone where to go for information to getting the information for them (a clearinghouse). This latter service becomes attractive if the information must be obtained from a number of sources. It is easy to envision a National Water Information Clearinghouse system developing by a National Water Information Referral Center gradually taking on more and more full service functions while at the same time providing guidance and assistance to individual state or regional organizations developing water information services.

ACKNOWLEDGEMENTS

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THE EFFECTS OF POTABLE WATER AND WASTEWATER ON THE DEVELOPMENT OF A COASTAL COMMUNITY

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Introduction

Waste disposal, in all of its incarnations, constitutes one of the most critical problems this country will face during the twentieth century. Solid waste, wastewater, hazardous wastes and radioactive wastes are pervasive in our environment. Collectively, they represent a dilemma of enormous magnitude. Solutions, however, lie in considering them individually. Each aspect must be viewed in terms of its own particular parameters, set within a framework of multi-media management. Neither contaminated drinking water nor polluted air are desirable. Nor, for that matter, are lifeless coastal seas or barren landfills. Yet the best available means of disposal may merely create less harm. Even this, however, may be a step forward in some areas.

Wastewater

Alternatively, it may be possible that a creative answer exists or can be developed for recycling the waste. Not only are detrimental consequences avoided, but a benefit may actually be derived from something that was formerly considered a nuisance.

Wastewater was selected as part of the subject of this research as all communities must contend with wastewater disposal. It is a common thread, even when the means of disposal vary. Not all communities must face radioactive or hazardous waste. Furthermore, wastewater disposal has traditionally been a problem that communities must deal with repeatedly, as a result of growth and aging. Initially, the community is faced with installation of a collection and disposal system. Later, the need to expand the system, to repair or replace deteriorating physical plant, to update obsolete equipment, and/or to meet new health and environmental standards can all be expected to arise--sometimes simultaneously. This pattern has changed little during this century. Old as well as new communities are faced with the need to develop an infrastructure that is environmentally sound, economically viable and socially just--no small task.

Furthermore, the steps that are taken to cope with these difficulties are going to help shape the nature of our society during the next century. The U.S. has historically viewed its abundant resources as virtually infinite. Modern society, with its "disposable" philosophy is the result. That there is a limit to our resources is now common knowledge. The questions that remain are whether society will choose to act responsibly and whether the ability to recycle will overcome the desire to discard. Wastewater can be viewed as a problem to be disposed of in the most convenient manner or as a valid resource that deserves reuse. Actually, a range of choices exists vetween these two extremes, e.g., a combination of recycling and disposal techniques, use of nutrient-rich "wastewater" for aquaculture, injection into aquifers of wastewater that has been treated sufficiently to render it safe for drinking, or an outfall into the deep ocean, with dilution and dispersal the eventual end of the wastewater.

The choices made will be reflections of the importance apportioned to the goals of reasonable economics, a clean environment and raised social consciousness. The price of a healthy environment is often high. Social justice may require rearrangement of the status quo. Either may interfere with economic stability. The ramifications of wastewater decisions made in the 1980's will still be affecting the quality of life after the year 2000. Whether the U.S. takes the path towards wise wastewater reuse and disposal, thereby conserving other resources, is a serious issue which has its roots in the present and impacts on the future. To make these decisions, i.e., to choose among the possibilities, requires information on the issues--a small portion of which may be found in this research.

Wastewater treatment and disposal may present problems for any urban center, but it poses an even more serious constraint to coastal communities. Effluent discharged into the nearshore environment can change the nature of nearby estuaries. Since estuaries serve as nurseries for the early life stages of many species, impacts may be especially detrimental. Treated wastewater may still contain harmful chemicals, capable of killing fauna outright or slowly accumulating within the animal's tissue. Not only may reproductive success be diminished, contaminated animals consumed by humans pose a real health hazard to the exposed population. Commercial and sports fisheries may be adversely affected, either because of reduced numbers of individual species or because of potential increases in contamination that may preclude harvesting.

If polluted waters prevent swimming, beach attendance is adversely affected. When sports fisheries are depleted, recreational fishermen must look elsewhere. The economics of coastal towns frequently depend on financial input from the tourist trade, and the impact of a decrease in spending can be devastating. Tourists are not likely to come to the coastal communities if they cannot participate in shoreline activities.

If effluent cannot be discharged into the marine environment, it may be disposed on land. Unfortunately, this alternative is not without negative impacts. Coastal communities, because of physical geography, often tend to have space limitations. Furthermore, coastal real estate may be valued far above comparable inland properties, making the land disposal of wastewater economically infeasible.

Potable Water

Another difficulty may arise with wastewater disposal on coastal lands. The water table in coastal areas tends to be shallow, making it more vulnerable to contamination. Aggravating this problem, often porous coastal soils may allow rapid percolation of wastewater. Potable surface water may be limited, as many coastal ponds are brackish and therefore unsuitable for drinking. Wastewater and potable water are inescapably intertwined. Even when heavily loaded with contaminants, the major component of wastewater is water. Consequently, both potable water and wastewater were examined. They are both fundamental constraints on a community.

Case Study

To examine the problems of potable water supply and wastewater treatment and disposal in coastal communities, a case study methodology was selected. The technique allows in-depth investigation, although the scope of work must be limited. The community selected was Hilton Head, South Carolina. Located on the southern end of the South Carolina coast, Hilton Head is a barrier island. Twelve miles long and five miles wide, Hilton Head has experienced most of its development during the last two decades, with much of this development subject to some form of planning. The community has only recently incorporated as a town, passing a referendum in May of 1983. Prior to this, the town was governed by a hodge-podge of layers of authority. (See Fig. 1)

Historical Background

In 1950, a group of Georgia businessmen bought most of the island for lumbering. One of the businessmen involved, Charles Fraser, came to believe that the island was far more valuable for its development potential than for its timber. Fraser, a graduate of Yale Law School, was determined to create a resort community on Hilton Head Island over which he would possess complete aesthetic control. (McPhee, 1971) When Fraser began his development of "Sea Pines Plantation" in rural Beaufort County, it was wholly unlike anyplace else in the county--indeed, perhaps in the entire state of South Carolina. The county had little experience with this sort of development and the process proved to be an educational experience for all involved.

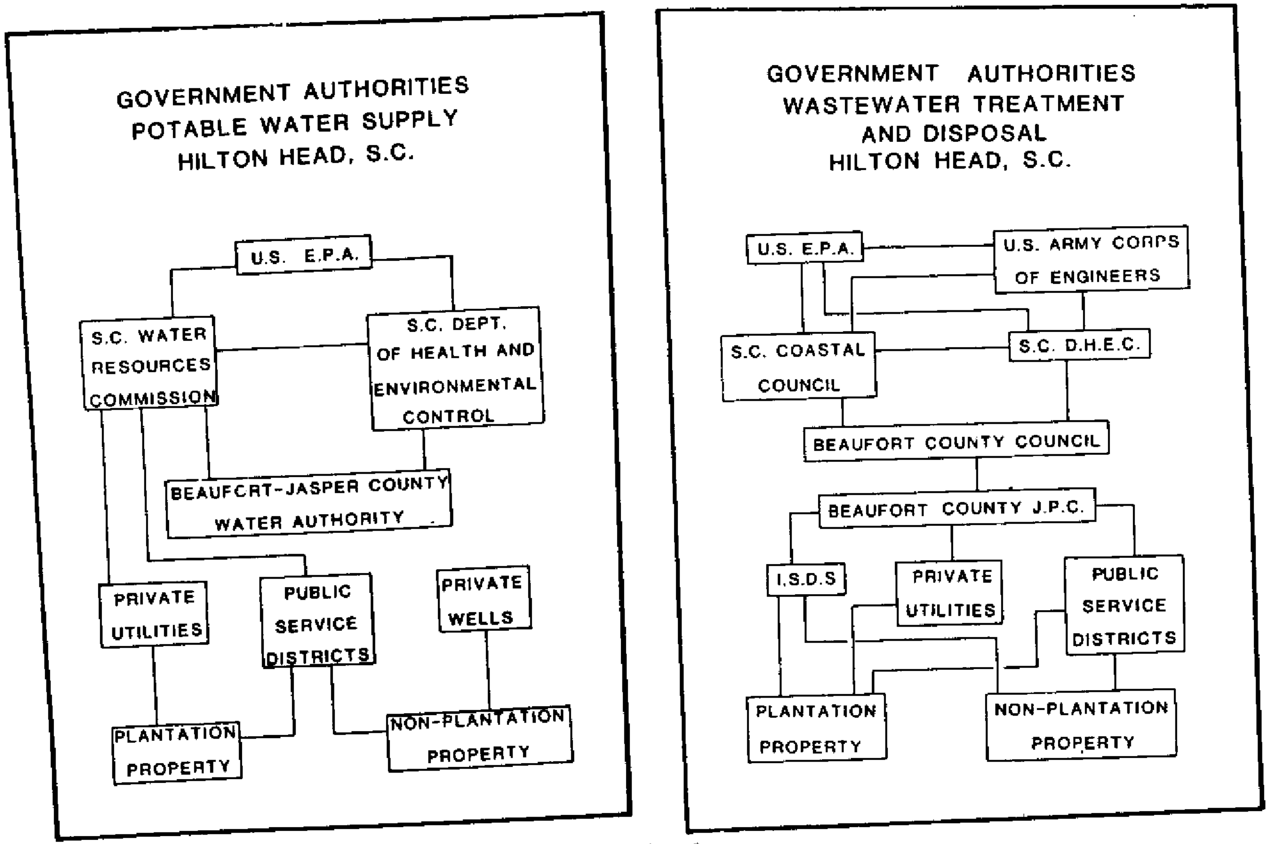
GOVERNMENT AUTHORITIES
POTABLE WATER SUPPLY
HILTON HEAD, S.C.
U.S. E.P.A.
S.C. WATER RESOURCES COMMISSION
S.C. DEPT. OF HEALTH AND ENVIRONMENTAL CONTROL
BEAUFCRT-JASPER COUNTY WATER AUTHORITY
PRIVATE UTILITIES
PUBLIC SERVICE DISTRICTS
PRIVATE WELLS
PLANTATION PROPERTY
NON-PLANTATION PROPERTY
GOVERNMENT AUTHORITIES
WASTEWATER TREATMENT
AND DISPOSAL
HILTON HEAD, S.C.
U.S. E.P.A.
U.S. ARMY CORPS OF ENGINEERS
S.C. COASTAL COUNCIL
S.C. D.H.E.C.
BEAUFORT COUNTY COUNCIL
BEAUFORT COUNTY J.P.C.
I.S.D.S
PRIVATE UTILITIES
PUBLIC SERVICE DISTRICTS
PLANTATION PROPERTY
NON-PLANTATION PROPERTY

Fig. 1

Current Situation

There is some polarization of black and white populations on the island. The blacks are largely native Southerners, whose ancestors may have resided on the island since the Civil War, or earlier. Many of them are the heirs of those forty acre farms granted to slave families by the post Civil War federal government. To some extent, the black population resents the changes that have been wrought on their island by the developers. (Campbell, 1983) While it is true that the new Hilton Head has created a surfeit of jobs for the local population, the positions available to blacks are strictly menial--chambermaids, waiters and waitresses, busboys and dishwashers. (Thomas, 1982) The bulk of the white population has migrated to the island within the last twenty years. Most are transplanted northerners. Their perception of Hilton Head is strongly influenced by the world they live in behind the guarded gates of the plantations.

Community Planning

Local authorities have tried to cope with the rapidly blossoming development. However, there is no limit on density of units per acre, nor are there zoning maps or regulations. The county government that was formerly responsible for these decisions in Hilton Head has given way to the municipal government of Hilton Head. However, the controversy surrounding a density cap continues. The county government, while studying the situation, had implemented a temporary development standards ordinance with a 4 units/acre limitation. This was to be a short term measure. The new municipal government has been unable to decide whether or not there should be a cap, nor, if established, what the cap should be.

Without a community zoning map, the legal basis for establishing density limitations is weak. The large plantations have developed their own masterplans for phased development. Nonetheless, there is tremendous pressure toward increased development, especially on the small tracts that are not masterplanned. In any case, the South Carolina Supreme Court has ruled that masterplans cannot be held to be binding documents and are in no way comparable to a community zoning map.

Traditionally, municipal government is responsible for decisionmaking regarding water supply and wastewater treatment and disposal. Such is not the case in Hilton Head. The referendum for incorporation succeeded on the argument that a limited service government could exist. Decisions are made, instead, by the Public Service Districts (PSDs)--designated areas, enabled by the State Legislature. (See Fig. 2) PSDs' authority may vary, but they are most often responsible for security, firefighting, water supply and wastewater treatment and disposal.

WASTEWATER FACILITIES
(PUBLIC SERVICE DISTRICTS
AND PRIVATE UTILITIES)

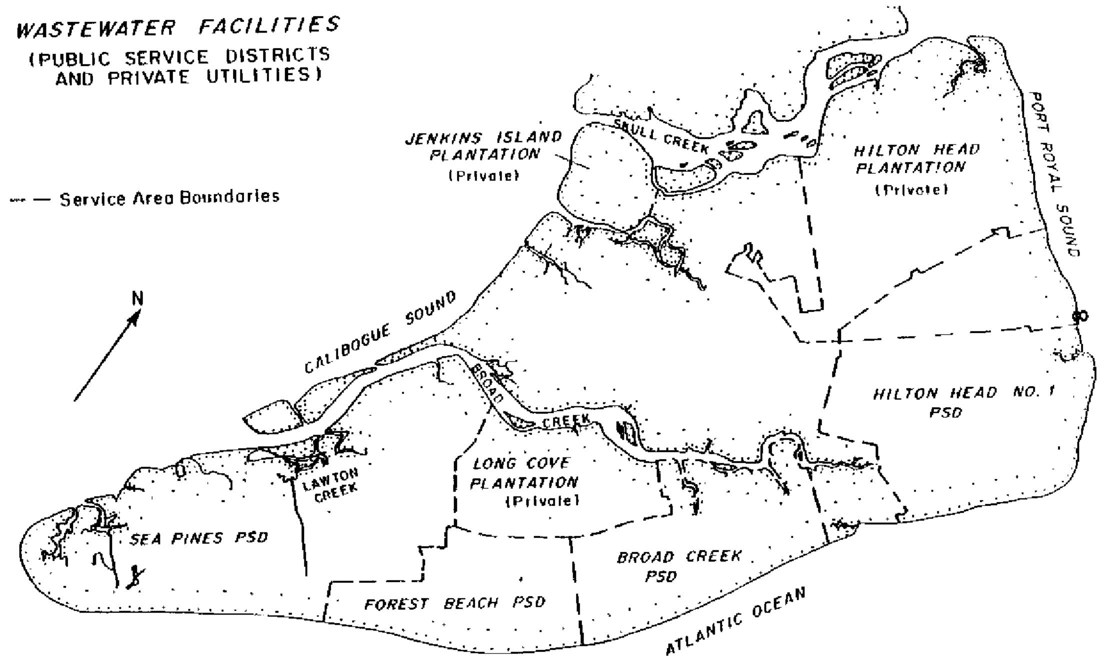

Fig. 2

Comprehensive Plan

Until recently, there had been no long term, concerted effort toward resolving water supply and wastewater disposal problems. About two years ago, the South Carolina Department of Health and Environmental Control (DHEC) became alarmed at the total treatment capacity for which they were receiving applications. DHEC slapped a moratorium on plant construction on Hilton Head Island and stated publicly that the moratorium would only be lifted when a satisfactory island-wide plan for wastewater treatment and disposal had been advanced. The moratorium was lifted less that a year ago, when island groups, after much refinement, presented a plan acceptable to DHEC.

Currently, wastewater on Hilton Head is treated to a secondary level. Some of it is disposed of by spray-irrigation on golf courses and other open space. The remainder is discharged into a canal, eventually reaching the ocean.

Furthermore, all potable water on the island comes from a sole source--an aquifer underlying the island. This underground water is part of the Tertiary Limestone Aquifer, which runs south to Florida. (Spigner and Ransom, 1979) The South Carolina Water Resources Commission (SCWRC) believes that the island is a recharge area for the aquifer. (Island Packet, 1982) The "minimum safe yield" which can safely be obtained from the aquifer is unknown, however, per capita usage of potable water is high. The SCWRC lists several major groundwater problems in the Beaufort County area, including:

(a) Regional water level declines throughout large areas of Beaufort County and adjacent counties in South Carolina and Georgia.

(b) Saltwater contamination of the Tertiary Limestone Aquifer, primarily in Beaufort County.

(c) Local well interference, where water levels have been lowered below some pump intakes.

(d) Interaquifer transfer, resulting in artesian pressure losses and/or water quality impairment. (Spigner and Ransom, 1979)

Saltwater intrusion is a growing concern to residents in the area. Although several hydrogeologic mechanisms contribute to the problem, the end result is the same; chloride contamination of groundwater.

Wastewater, Potable Water and Planning

The history of community planning and implementation is a relatively recent one. Hilton Head is a modern community, i.e., one that has undergone most of its development relatively recently. Literature about the island touts all of the planning involved in its development.

Wastewater collection, treatment and disposal and potable water supply all have impacts on a community's growth. If the community ignores this, then the impact is uncontrolled, and may very well be adverse. Alternatively, recognizing their potential usefulness and deliberately manipulating the nature and placement of the effects can aid a community interested in directing its own future.

Typically, problems in wastewater treatment and disposal systems have been solved using a "crisis-resolution" type of model (i.e., until a crisis arises, the problem is rarely discussed). Nor is any planning involved to avoid or minimize the problem. A solution may only be researched after the emergency has forced some acknowledgement of the problem. While this response pattern is still prevalent in many communities, planners and engineers have begun to recognize that sewage policies do affect urban structure, and when used in conjunction with other controls, they can become a powerful tool for implementing urban planning. (Tabors, et al, 1976)

Hilton Head goes to great lengths to portray an image of environmental concern, with ecological balance of utmost consideration. In actuality attention has been devoted to "environmental aesthetics," rather than the environment, per se. One can work to encourage green lawns and to save old trees and yet not understand the delicate balance in the environment itself. Even on Hilton Head, there is a predilection for draining marshes in favor of residential development.

There are a number of planning tools available to communities, including; zoning maps and regulations, density standards, transferable development rights, judicious use of sewerage, treatment plants and wastewater disposal, control of watershed and limiting water supply.

The overriding concern, of course, is economics, even though it is a less serious constraint in Hilton Head than in most communities. Environmental soundness and social justice are desirable goals, but economics dominate decisionmaking in wastewater and water supply systems.

Summary

Hilton Head, as a new community, interested in promoting planning and with less serious economic constraints than most, has still encountered an inability to deal with, and especially to anticipate water supply and wastewater disposal problems. The community has not yet even begun to consider the problems that can arise from deterioration due to aging, technological obsolescence and long term systems maintenance. They are refusing to consider that planning for sludge disposal even merits consideration.

Nonetheless, forced to respond by the DHEC moratorium requiring a comprehensive plan, Hilton Head has begun to recognize the potential for waste disposal as a planning tool. They have contrived a comprehensive wastewater treatment plan that will bring all treatment on the island (current and future) to tertiary levels. All wastewater will be sprayed on land, irrigating golf courses and green spaces and perhaps returning water to freshwater marshes that are drying out as a result of changes in drainage patterns. Two outfalls to the ocean will function only in emergencies. The plan should help to relieve aquifer drawdown beneath the island, thereby slowing the progress of saltwater contamination.

It is possible that the plan will help force an equilibrium carrying capacity on the island, i.e., with only very limited ocean disposal and no piping of wastes to the mainland, the ability of the land to absorb waste can play a limiting role in development. More so than inland areas, Hilton Head and other communities that share some of its traits face an uncertain future. The attractiveness of the coast continues to draw people to it. The swelling population puts a strain on the ability of the community to supply a reasonable quality of potable water and to adequately treat and dispose of wastewater. Furthermore, these needs often conflict with efforts to maintain the quality of nearshore marine waters. The key lies in thoroughly researching the problems, anticipating their occurence and planning how to avoid them or to mitigate their impacts.

Disclaimer:

This research represents only the opinion of the author and in no way relates to any official policies of the Office of Ocean and Coastal Resource Management and/or the National Oceanic and Atmospheric Administration.

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LOCAL ENVIRONMENTAL PROTECTION THROUGH INCREASED CITIZEN PARTICIPATION

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In responding to pollution problems, many environmental organizations focus their efforts on the clean-up of contaminated areas. Long-term protection of the environment, however, requires preventative as well as corrective action. In Rhode Island, Save The Bay, Inc., a regional organization, recognized this situation and in 1982 began a new approach to environmental advocacy with a pollution prevention project. The following paper describes the recent success the Project has had in promoting environmental problem-solving at the local level.

Background - Narragansett Bay

Located primarily in Rhode Island, Narragansett Bay is considered a unique and very productive estuary. The Bay, which covers 102 square miles, suffers from a long history of pollution that dates back 200 years to when industries first dumped wastes into the Providence River at the head of the Bay. Today, over 10,000 acres are closed to shellfishing activities because of sewage pollution. Recent studies indicate toxic and non-point pollution are also adversely affecting the Bay. Aquidneck Island, the largest island in the Bay, was selected as the subject of the pollution prevention project.

Background - Save The Bay, Inc.

Save The Bay is a private, non-profit organization dedicated to protecting the water quality and coastal environment of Narragansett Bay. The organization has a small paid staff and makes use of a large volunteer force. For most of its fourteen-year history, Save The Bay has focused on correcting existing pollution problems. While continuing such efforts, Save The Bay recognized that preventative action was also necessary. To address this need, Save The Bay received grant funding to pursue a new approach to environmental advocacy and began the Aquidneck Island Pollution Preven-Project in 1982.

The Aquidneck Island Pollution Prevention Project

The Aquidneck Island Project was designed to prevent pollution problems on the Island through research, public education and citizen involvement programs. The Project focused on organizing citizens at the local level around environmental issues. The local focus was in part a response to a growing frustration with the limitations of state and federal agencies, as well as recognition that the primary control of land use activities which directly and indirectly affect water quality lies with local authorities.

The Project has been essentially an experiment in citizen participation and is based upon the premise that an informed public active in decision-making processes can influence local governments to take action to protect the environment. Furthermore, it was assumed, based on Save The Bay's experience, that the majority of work required for this citizen involvement can be carried out by properly trained and organized volunteers. This paper describes two instances where citizen involvement has resulted in public action.

Watershed Protection and the Middletown Comprehensive Plan

Sixty-five percent of the Town of Middletown (located on Aquidneck Island) lies within the watersheds of the Island's drinking water supply reservoirs. These reservoirs are shallow (8 to 15 feet deep) and have been adversely affected by non-point pollution sources including urban and agricultural runoff. They have become eutrophic, supporting algal blooms which make water treatment difficult. On occasions, these conditions result in concentrations of trihalomethanes (chlorinated by-products of the treatment process) in the drinking water in excess of federal standards.

To prevent water quality conditions from further deterioration, land use controls in the watershed areas need strengthening. In 1982, a consultant was hired by the Town to draft a comprehensive land use plan. This provided the opportunity for improving watershed protection, although similar planning efforts had twice before failed due to a lack of public support.

Save The Bay's work with the consultant on the plan resulted in the recommendation of special watershed sensitivity districts. Recognizing that the plan would go to a public hearing, Save The Bay prepared and distributed educational materials describing the need for and the benefits of adopting the plan. At the first public hearing, Save The Bay spoke in favor of the plan, along with several neighborhood and local environmental groups as well as individuals, in an organized display of support. Few objections were raised at the hearing however publicity about the plan, specifically its watershed protection measures,attracted attention. By the next meeting, when the Town Council was to consider a vote to adopt the plan, a petition had been organized by objectors to extend the hearing process. The objectors were primarily the owners of large tracts of undeveloped land who would be affected by zoning changes. They represented a political force and a real threat to the adoption of the plan. Using action alert mailings, which generated phone calls to town council members, and other techniques, Save The Bay organized an even stronger show of support for the plan. Save The Bay was able to bring technical experts to testify at the hearings , and their information, coupled with articulate testimony from local residents made for a strong presentation. As a result, the plan was adopted with a compromise from 2-acre to 1½-acre zoning in certain watershed areas. The effectiveness of the plan will hinge on its implementation through the zoning ordinance and other regulations. The coalition of groups organized to work for adoption of the plan has kept in contact and is preparing now for hearings on proposed zoning changes. Meanwhile, four requests by developers for rezoning or special exceptions from the plan's recommendations for watershed areas have been turned down due to watchdogging by neighboring groups. This vigilance has maintained the integrity of the Plan.

Discharge of Untreated Sewage into Newport Harbor

The City of Newport faces several problems in upgrading its overburdened sewage treatment system. One problem is the discharge of untreated sewage and stormwater into the Newport Harbor through combined sewer overflows (CSO's). At Long Wharf in the corner of the Harbor a 72-inch diameter pipe regularly serves as a CSO after rainstorms. Plans to build a micro-straining facility to treat the discharge were scrapped after numerous problems with the technology developed at a CSO treatment facility on the opposite end of the harbor. As a result, millions of gallons of sewage mixed with stormwater is discharged untreated into a harbor that heralds itself as the yachting capital of the world.

Over the years, citizens complained but there was never an organized effort to tackle the problem at Long Wharf. After scrapping its original plans the City's position was one of no action. In June 1984, a major rainstorm resulted in CSO discharges that so heavily contaminated the harbor, a public beach was closed. Water quality standards required the number of fecal coliform bacteria per 100 ml not exceed an average of 50. Actual samples ranged from 9,300-15,000. This event, and the publicity surrounding it, generated public interest and served as a catalyst for citizen action.

In July, with cooperation of over 20 groups representing commercial fishing, business, neighborhood and boating interests, Save The Bay organized and carried out Newport Harbor Appreciation Week. The week included boat tours of the harbor, radio shows and other activities that highlighted the CSO problems and fostered greater appreciation of the harbor.

At the completion of the week, the coalition of groups that had participated was asked to support a call for action - a moratorium on all new hook-ups to the overburdened sewer system. At the time, the sewage plant which was designed to treat 5.8 million gallons a day (MGD) was receiving an average of 10.5 MGD. Given the building boom in time-share hotels and condominiums that has accompanied the promotion of tourism in Newport, the moratorium request was controversial and resulted in extensive media coverage.

By pressing for action in a coalition, Save The Bay was able to back up its position with not only legal and engineering expertise, but also the solid support of local residents. After several meetings, the City and Department of Environmental Management (the state agency with enforcement powers), came to an agreement in September about the actions to be taken. Under a consent agreement, the City was required among other things, to perform monitoring and water quality sampling of the CSO discharge, to repair a broken tide-gate at the CSO and connect a larger force main to the treatment plant. The agreement further set the conditions for when a moratorium would go into place. While falling short of achieving an immediate moratorium, the coalition's effort was very successful in light of the fact that three months earlier the city had no clear strategy for solving the CSO problem. After considering various options, the

City Council rejected a no-action position and authorized the studies necessary for pursuing federal marine CSO construction grant funds.

These two experiences have convinced Save The Bay of the following;

1. To address non-point pollution problems, regional environmental organizations need to increase their involvement in local land use planning and decision-making. The most effective way to do this is to work through coalitions formed among regional and local groups, and individuals. A consultant to Save The Bay has noted that solving most environmental problems translates into solving political problems. Capitalizing on the clout of the voter by working in a grass-roots organizing manner is essential to encouraging environmentally sound decisions from local governments. Encouraged by the impact of the Aquidneck Island Project, Save The Bay plans to extend its working relationships to local groups throughout the region.

2. In Rhode Island, public participation is often so low that it is often not as difficult as one expects to influence decisions. For example, in Middletown, five phone calls to a town council member was deemed significant, while ten calls might be interpreted as a crisis. A factor favoring this situation is the small size of the state which tends to make all government officials more accessible.

3. Public education is crucial to influencing policy decisions. Target audiences for any educational campaign should include decision-makers, press and media, and the general public. For complicated environmental issues, such as the cumulative effects of urban runoff on a water body, the need for public education will be on-going. It is also important to talk to and get information to decision-makers in advance of decisions to be most effective. In planning an educational campaign concerning preventative actions or long-term solutions, environmental groups must recognize the highly "reactive" nature of local governments and build arguments for action that are backed by strong and vocal public support.

4. In any effort to influence a decision, environmental groups must insure that their information is accurate. Nothing is as ineffective as delivering misinformed testimony at a public hearing. Such occurances damage not only a group's immediate participation in the hearing, but also the credibility of their participation in future decisions.

To improve water quality and protect coastal natural resources environmental advocates must continue to work at the federal, state and local government levels. As a regional organization, Save The Bay has traditionally focused on influencing federal (EPA) and state regulatory agency decisions. Noting, however, that in Rhode Island, state agencies often have insufficient funding or political incentive to move aggressively, Save The Bay has addressed environmental issues by focusing on local government decisions. By doing so, the connection between land use activities and water quality has become clearer and the organization even more convinced that organizing local citizens action is essential to the long-term protection of Narragnasett Bay.

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NATIONAL MARINE POLLUTION ISSUES -- STATE AND REGIONAL PERSPECTIVES [1]

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Introduction

The National Ocean Pollution Planning Act (NOPPA, P.L. 95-273, as amended) was enacted in 1978 for the purpose of improving the coordination of federally conducted or supported marine pollution research, development, and monitoring activities. To meet this objective, the statute requires that the National Oceanic and Atmospheric Administration (NOAA) coordinate the preparation and implementation of a comprehensive five-year Federal Plan for Ocean Pollution Research, Development, and Monitoring. Section 4(b)(1) of NOPPA requires that the Plan identify those national needs and problems, related to specific aspects of marine pollution, which exist and will arise during the Plan period.

Within NOAA, the responsibility for implementing Section 4 of NOPPA has been assigned to the National Marine Pollution Program Office (NMPPO). To assist in identifying the leading national needs and problems, NMPPO undertook two major efforts during 1984. The first

1. VIMS Contribution No. 1239.

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3. Present address: National Marine Pollution Program Office, NOAA, 5640 Nicheolson Lane, Rockville, MD 20852.

effort consisted of a Workshop on National Marine Pollution Research and Monitoring Issues which was convened during May of 1984. A total of 65 participants, representing diverse concerns related to marine pollution, participated at this workshop, developing a ranked list of 50 national marine pollution issues. The second effort involved a regional assessment of these issues by representatives of state coastal zone management (CZM) offices and institutions affiliated with the National Sea Grant College Program. During the summer of 1984, a total of 71 individuals completed this assessment. This paper provides a brief description of the approach used to develop the ranked issues and the results of the state and regional assessment.

Approach

A software package, "Decision Analysis by Paired Comparisons" (DAPC) developed by the Pacific Northwest Laboratory, facilitated the production of a ranked list of issues. Three main steps are involved in this process: (1) development of a list of marine pollution issues; (2) weighting of criteria used to evaluate the issues; and (3) evaluation of the significance of each issue with respect to each criterion.

The 50 marine pollution issues used in the state and regional assessment were identified by participants at the national workshop on the basis of guidelines developed by NMPPO. The following definition of a national marine pollution issue was employed for the sake of the national workshop:

> "Marine pollution issues include areas of major public concern with respect to effects of human activities on the marine environment, the introduction of specific pollutants into the marine environment, and the general condition of marine ecosystems. These issues should be of concern nationally such that they warrant the investment of Federal funds for research and monitoring to assist decisions on appropriate uses of the marine environment."

Issues identified, therefore, were related to one of the three categories of concern set out in the definition above: (1) effects of human activities; (2) effects of specific pollutants; and (3) the general condition of marine ecosystems.

The seven criteria for the state and regional assessment were developed by NMPPO and were also used at the national workshop to evaluate the significance of the issues. In determining the criteria to be used, particular attention was given to selecting criteria which were consistent with the requirements established by NOPPA. This act requires an identification of "national needs and problems which relate to specific aspects of marine pollution (including, but not limited to, the effects of marine pollution on the economic, social, and environmental values of ocean and coastal resources which exist and will arise during the Plan period)." The criteria used to evaluate marine pollution issues are based on such considerations. Weights were assigned to the criteria to indicate the relative significance of each criterion. Weights were applied, using the DAPC system, through an exercise in which each of the possible pairs of criteria were examined, and a selection was made as to which member of each pair was most important. The criterion weights which are described with the results are specific to the state and regional assessment.

The third step in the process involved an evaluation of the significance of each issue with respect to each criterion using a 0-9 scoring scale. The DAPC system incorporated the criterion weighting factors developed in the previous step and provided a quantitative score for ranking the issues in priority order. An important difference between the national workshop and the state and regional assessment is that participants at the workshop were instructed to evaluate the significance of the issues strictly from a national perspective, whereas participants in the second evaluation were requested to evaluate the same issues only from a regional perspective.

Results

The results of this state and regional analysis are presented in three parts. The first section discusses the assignment of weighting factors to the evaluation criteria by the representatives of each of the groups evaluated. Next, the ranking of the issues by representatives of the coastal zone management offices and the Sea Grant institutions were analyzed and compared to determine if the perceptions of priority issues were consistent between the two groups. In the final section, results by coastal regions were determined by combining the results from the coastal zone management offices and the Sea Grant institutions and grouping them into four regions listed below:

1) Northeast and Mid-Atlantic Region

Maine	Rhode Island	New Jersey	Maryland
New Hampshire	Connecticut	Delaware	Virginia
Massachusetts	*New York		

2) South Atlantic and Gulf of Mexico Region

North Carolina	Florida	Louisiana	Puerto Rico
South Carolina	Alabama	Texas	Virgin Islands
Georgia	Mississippi		

3) West Coast Region

California	Washington	Hawaii	Guam
Oregon	Alaska	Amer. Samoa	Northern Marianas

4) Great Lakes Region

* New York	Ohio	Indiana	Wisconsin
Pennsylvania	Michigan	Illinois	Minnesota

Results from the four regions are then compared for consistency.

*The same input from New York was used for both the Northeast and Great Lakes regions

(1) Assignment of Criterion Weights

Table 1 presents a comparison of the mean criterion weights as assigned by representatives of the coastal zone management offices, the Sea Grant institutions, and the combined weights assigned by these two affiliations grouped into the four regions.

Both the coastal zone management offices and the Sea Grant institutions assigned the highest weighting factors to the criteria related to human health and the integrity of marine ecosystems. The Sea Grant representatives considered human health the most important criterion for evaluating marine pollution issues, while the representatives from the CZM offices considered the integrity of marine ecosystem the most important criterion. The representatives from the state CZM offices assigned a relatively high weighting factor to the criterion related to the recreational uses of the marine environment. This criterion, in contrast, was given the lowest weight by the representatives of Sea Grant. The remaining criteria were ranked similarly by the two groups.

Analysis by coastal regions indicates that all four regions assigned the highest weights to the criteria related to human health and the integrity of marine ecosystems. The criterion related to commercial and recreational fisheries was given the third highest weight by all four regions. The greatest difference between the regions concerned the criterion related to recreational uses of the marine environment. Both the Southeast and Northeast regions assigned the lowest weight to this criterion, while the West Coast and Great Lakes regions both assigned it a relatively higher weight.

(2) Comparison of Results: Sea Grant Vs. CZM Offices

Table 2 presents the ranks and scores assigned to each of the issues by representatives from the CZM offices and Sea Grant institutions. Although the representatives from the CZM offices generally assigned higher scores to specific issues than did the representatives from Sea Grant, the relative ranks assigned to the 50 issues by the two groups were generally consistent. Both groups identified synthetic organic chemicals, polynuclear aromatic hydrocarbons, and pathogens as high priority pollutants. Pipeline discharges of industrial and municipal wastes were the polluting activities of greatest concern to both groups. Representatives from Sea Grant and the CZM offices also expressed a high level of concern for the cumulative effects of man-induced activities in coastal areas.

The areas of difference between the two groups include perspectives on ocean dumping which was considered a high priority by CZM respondents in contrast to respondents from the Sea Grant institutions. Additional differences include the importance of issues related to high-level radioactive waste disposal and the validity of existing analytical techniques. Representatives of the CZM offices assigned a high priority to the issue concerning sub-seabed emplacement of high-level radioactive wastes while the Sea Grant representatives considered this of lesser concern. The Sea Grant representatives considered the validity of existing analytical techniques as a high priority issue, while representatives of the CZM offices attached less significance to the issue.

Table 1. Criteria and Mean Criterion Weights as Assigned by Representatives of Sea Grant (SG), CZM Offices (CZM), and the Northeast (NE), Southeast and Gulf of Mexico (SE), West Coast (WC), and Great Lakes (GL).

CRITERION	CRITERION WEIGHT					
	SG	CZM	NE	SE	WC	GL
How significant is this issue to human health?	23.0	20.4	23.2	20.5	18.7	26.8
How significant is this issue to the integrity of marine ecosystems, including threatened species?	22.3	21.5	21.9	22.2	20.6	22.9
How significant is this issue to commercial and recreational fishery resources?	14.5	17.4	14.4	17.1	16.0	17.3
What is the likelihood that research on this issue will help resolve the issue?	14.1	10.0	13.3	12.0	12.4	8.6
What is the potential economic significance of controlling pollution to the impact-producing activity or industry (and consumers)?	10.3	10.1	12.4	9.5	10.3	8.2
Is this issue likely to increase or decrease in significance in the next five years?	8.6	9.9	8.8	11.4	8.2	7.3
How significant is this issue to non-fishery related recreational uses and aesthetics of the marine environment?	6.7	10.4	5.6	7.0	13.6	8.6

Table 2. Issue ranks and mean scores: Sea Grant and CZM offices.

Sea Grant		CZM		ISSUE
Rank	Score	Rank	Score	
1	701	2	736	Effects of synthetic organic chemicals on the marine environment
2	678	6	704	Cumulative effects of man-induced changes on selected coastal areas and estuaries
3	676	1	748	Comparative assessment of various media for waste disposal
4	673	4	725	Effects of pipeline discharge of industrial waste
5	659	26	629	Validity of existing analytical techniques as appropriate indicators of pollution impacts
6	659	18	669	Effects of pipeline discharge of sewage sludge
7	647	13	679	Effects of pipeline discharge of municipal wastewater
8	645	27	625	Effects of introducing human pathogens into the marine environment
9	643	15	673	Consequences of modification and loss of wetlands
10	641	3	734	Long-term effects of polynuclear aromatic hydrocarbons and their metabolites in the marine environment
11	639	8	697	Effects of introduced pathogens on marine organisms
12	639	7	700	Effects of urban and suburban nonpoint source contamination in estuaries and coastal areas
13	637	22	660	Adequacy of baseline information
14	632	9	695	Deterioration of the Great Lakes as a drinking water source
15	631	12	684	Effects of nutrient loading on estuaries, coastal zones, and the Great Lakes
16	630	14	675	Effects of ocean dumping of industrial wastes

Table 2 (cont'd)

Sea Grant		CZM		
Rank	Score	Rank	Score	ISSUE
17	623	11	685	Effects of agricultural non-point source contamination in estuaries and coastal areas
18	616	24	638	Sufficiency of indices to distinguish between natural and anthropogenic change
19	606	10	692	Effects of ocean dumping of sewage sludge
20	603	25	632	Consequences of modification and loss of submerged aquatic vegetation in the nation's estuaries and coastal areas
21	597	23	638	Effects of pollution-induced stress on susceptibility to pathogens
22	582	17	669	Effects of metals on the marine environment
23	573	20	664	Effects of oil spills on the marine environment
24	568	21	661	Environmental impacts from transport, handling, and storage of waste materials to be incinerated at sea
25	563	19	667	Long-term effects of petroleum compounds and their metabolites in the marine environment
26	557	36	585	Effects of freshwater pollution on anadramous fish populations
27	552	33	590	Effects of dredging on near-shore environments
28	550	35	588	Effects of ocean dumping of dredged material
29	549	5	715	Effects of sub-seabed emplacement of high-level radioactive waste
30	539	28	618	Effects of altering salinity regimes in coastal and estuarine and areas from water-use practices
31	530	16	671	Effects of ocean dumping of low-level radioactive waste
32	526	30	606	Consequences of modification and loss of coral reefs

Table 2 (cont'd)

Sea Grant		CZM		ISSUE
Rank	Score	Rank	Score	
33	524	37	579	Onshore physical impacts of offshore oil and gas activities
34	514	29	615	Impacts of chronic discharges from offshore oil and gas activities
35	489	31	602	Significance of cumulative effects of outer continental shelf oil and gas development and transportation activities
36	477	32	593	Environmental impacts of at-sea incinceration of wastes
37	473	34	589	Effects of outer continental shelf-related resource development on Arctic and sub-Arctic environments, including subsistence species
38	471	38	576	Effects of forest practices on estuaries and coastal areas
39	463	40	543	Effects of mining sand, gravel, and phosphates
40	460	41	534	Effects of thermal discharges on the marine environment
41	426	47	451	Effects of sea level rise on coastal ecosystems
42	424	49	431	Effects of debris ingestion by marine biota
43	397	39	552	Effects of mining polymetallic sulfides
44	382	31	602	Significance of entanglement of marine organisms in ghost nets, traps, and other debris
45	379	45	463	Effects of brine from desalinization and salt domes
46	375	44	463	Effects of entrainment/impingement associated with powerplants
47	353	46	458	Effects of storage and transshipment of coal
48	341	43	485	Effects of mining manganese nodules and crusts
49	318	42	492	Effects of ocean thermal energy conversion development
50	308	50	395	Effects of electromagnetic pulse testing on marine biota

(3) Comparison of Regional Results

The objective of this analysis is to indicate similarities and differences among the priority issues identified by the four regions. Table 3 presents the ranks and scores assigned to the 50 issues by representatives of each region. Although the scores serve as an indication of the priority of the issues, the ranges of the scores vary considerably among the regions. For this reason, ranks assigned to the issues, rather than the scores, have been used to indicate the priority of issues. Since it has arbitrarily been decided to limit consideration to high priority issues, only the top fifteen issues on each list will be noted. For this discussion the issues have been grouped into the categories of polluting activities, pollutants, and generic issues (those not related to a specific polluting activity or pollutant), and their ranks are compared by region.

The polluting activity of major concern to all four regions was marine disposal of municipal and industrial wastes. With respect to waste disposal, the Southeast and West Coast regions were primarily concerned with the nearshore effects of pipeline discharges of various wastes, while the Northeast and Great Lakes regions identified ocean dumping of sewage sludge as a high priority issue. All of the regions except the Great Lakes identified comparative assessment of various media for waste disposal as a high priority issue. In addition, cumulative impacts of man's activities in nearshore areas was identified as a high priority issue by all the regions.

Urban nonpoint source pollution was identified as a high priority polluting activity by the Northeast, Southeast, and Great Lakes regions, and was considered moderately important by the West Coast. The Great Lakes region also considered agricultural nonpoint source pollution as a high priority, while the Northeast and Southeast considered it to be a moderate priority issue.

Certain polluting activities were of high priority to only one region. The Northeast was the only region to identify sub-seabed emplacement of high-level radioactive waste as a priority, and the Southeast was the only region to consider the transport, handling, and storage of wastes for incineration at sea as a priority. Similarly, the Great Lakes was the only region to identify oil spills as a priority.

Synthetic organic chemicals were perceived as the most important pollutant for three of the regions, while the West Coast considered them to be a moderate priority pollutant. Pathogens were identified as at least moderately important to all of the regions. Polynuclear aromatic hydrocarbons and nutrients were identified as relatively high priority pollutants by all of the regions except the West Coast.

Habitat modification (Specifically the loss of wetlands and coral reefs) was especially important to West Coast representatives. Wetland loss was a moderately important issue for the Southeast and Great Lakes regions, while only the Great Lakes region identified the loss of submerged aquatic vegetation as a relatively high priority. The Northeast was the only region that failed to identify any habitat issue (wetlands, submerged aquatic vegetation, or coral reefs) as a priority.

Table 3. Issue ranks and mean scores: regional evaluation.

REGIONAL RANKS AND SCORES								ISSUE
Northeast		Southeast		West Coast		Great Lake		
Rank	Score	Rank	Score	Rank	Score	Rank	Score	
1	715	6	693	1	708	9	701	Effects of pipeline discharge of industrial waste
2	708	2	739	12	650	1	821	Effects of synthetic organic chemicals on the marine environment
3	705	1	748	2	701	17	663	Comparative assessment of various media for waste disposal
4	701	20	633	30	574	2	759	Effects of ocean dumping of sewage sludge
5	697	9	676	18	630	12	674	Effects of introduced pathogens on marine organisms
6	685	4	700	16	640	7	715	Long-term effects of polynuclear aromatic hydrocarbons and their metabolites in the marine environment
7	673	5	694	5	679	4	739	Cumulative effects of man-induced changes on selected coastal areas and estuaries
8	671	25	610	20	630	3	743	Deterioration of the Great Lakes as a drinking water source
9	667	8	682	14	648	10	693	Effects of urban and suburban nonpoint source contamination in estuaries and coastal areas
10	661	3	700	11	655	28	606	Effects of pipeline discharge of sewage sludge
11	654	13	669	24	614	8	708	Effects of nutrient loading on estuaries, coastal zones, and the Great Lakes
12	652	12	671	22	626	11	676	Effects of ocean dumping of industrial wastes
13	646	19	635	25	612	20	648	Effects of sub-seabed emplacement of high-level radioactive waste
14	645	16	644	15	643	32	587	Effects of introducing human pathogens into the marine environment
15	644	14	655	19	630	6	717	Effects of agricultural nonpoint source contamination in estuaries and coastal areas
16	640	7	682	4	680	19	653	Effects of pipeline discharge of municipal wastewater

Table 3 (cont'd)

REGIONAL RANKS AND SCORES								ISSUE
Northeast		Southeast		West Coast		Great Lake		
Rank	Score	Rank	Score	Rank	Score	Rank	Score	
17	640	23	619	21	627	21	630	Effects of metals on the marine environment
18	638	28	583	17	635	13	674	Effects of oil spills on the marine environment
19	637	21	624	13	649	37	535	Effects of pollution-induced stress on susceptibility to pathogens
20	621	11	671	7	671	14	669	Consequences of modification and loss of wetlands
21	619	22	620	26	607	39	509	Effects of ocean dumping of low-level radioactive waste
22	615	24	618	27	599	15	668	Consequences of modification and loss of submerged aquatic vegetation in the nation's estuaries and coastal areas
23	611	31	571	41	500	25	619	Effects of ocean dumping of dredged material
24	610	27	596	9	663	31	590	Long-term effects of petroleum compounds and their metabolites in the marine environment
25	594	15	648	28	596	26	616	Environmental impacts from transport, handling, and storage of waste materials to be incinerated at sea
26	587	18	638	3	686	5	731	Adequacy of baseline information
27	586	17	640	8	664	27	609	Sufficiency of indices to distinguish between natural and anthropogenic change
28	586	10	675	6	671	18	661	Validity of existing analytical techniques as appropriate indicators of pollution impacts
29	579	30	572	34	546	29	600	Effects of dredging on near-shore environments
30	573	33	552	29	578	33	584	Impacts of chronic discharges from offshore oil and gas activities
31	564	26	605	31	568	35	562	Effects of altering salinity regimes in coastal and estuarine areas from water-use practices
32	560	29	579	38	514	16	665	Effects of freshwater pollution on anadromous fish populations

Table 3 (cont'd)

REGIONAL RANKS AND SCORES								ISSUE
Northeast		Southeast		West Coast		Great Lake		
Rank	Score	Rank	Score	Rank	Score	Rank	Score	
33	557	35	525	42	498	30	591	Environmental impacts of at-sea incineration of wastes
34	533	40	499	10	659	24	620	Consequences of modification and loss of coral reefs
35	529	34	530	33	553	23	625	Significance of cumulative effects of outer continental shelf oil and gas develop ment and transportation activities
36	502	42	429	49	329	36	556	Effects of sea level rise on coastal ecosystems
37	494	32	553	32	559	22	629	Onshore physical impacts of offshore oil and gas activities
38	486	38	513	37	542	34	571	Effects of outer continental shelf-related resource development on Arctic and sub-Arctic environments, including subsistence species
39	484	39	502	35	545	45	439	Effects of thermal discharges on the marine environment
40	457	50	314	50	324	50	224	Effects of electromagnetic pulse testing on marine biota
41	453	44	423	39	513	41	496	Effects of mining polymetalic sulfides
42	449	47	380	40	511	49	349	Effects of debris ingestion by marine biota
43	448	37	517	23	621	38	532	Effects of forest practices on estuaries and coastal areas
44	443	36	522	36	544	40	507	Effects of mining sand, gravel, and phosphates
45	431	48	372	47	395	42	486	Effects of brine from desalinization and salt domes
46	410	46	389	43	472	48	360	Significance of entanglement of marine organisms in ghost nets, traps, and other debris
47	409	43	428	45	435	47	408	Effects of entrainment/impingement associated with power plants
48	399	45	401	46	423	46	429	Effects of mining manganese nodules and crusts
49	391	49	344	44	461	44	457	Effects of ocean thermal energy conversion development
50	385	41	430	48	361	43	471	Effects of storage and transshipment of coal

The West Coast was especially concerned with several additional issues which address generic aspects of marine pollution issues: validity of analytical techniques; adequacy of baseline information; and sufficiency of indices. The Southeast also ranked the issue related to the validity of analytical techniques as a high priority, and the Great Lakes ranked the adequacy of baseline information as a high priority. The Northeast, in contrast, did not consider any of these issues as a high priority. Only the Northeast and Great Lakes regions identified the deterioration of the great lakes as a drinking water source as a high priority issue.

Although several polluting activities, pollutants, and generic issues were ranked specifically on the basis of special regional concern, there was general agreement in certain areas by all four regions. Pipe-line discharges of industrial wastes and sewage sludge were identified as priorities by all of the regions, with discharges of industrial wastes a high priority in each case. Urban and suburban nonpoint source pollution was another polluting activity of concern to all of the regions, and synthetic organic chemicals and pathogens were identified as significant pollutants by each of the regions.

Conclusions

The results of this exercise must be interpreted within the context of the limitations of the methodology. These results represent the opinions of the researchers and managers who completed the evaluation. The selection of the evaluators, therefore, is an important factor contributing to the outcome of the assessment. Results of the evaluations by individuals associated with coastal zone management offices and those representing National Sea Grant institutions have been analyzed separately to see if perspectives of the two groups differ greatly. These two groups were then combined for the sake of the regional analysis.

An important feature of this assessment is that the issues were determined by participants at the national workshop. However, the independent assignment of criteria weights and evaluation of the issues helped to produce a set of results indicative of the perspectives of the state and regional evaluator.

A final consideration is that the criteria used may not apply equally well to all the issues listed and may, therefore, be difficult to assess against some of the issues. If some criteria did not apply to an issue, that issue may have a score which is not representative of its real importance. A common understanding among all participants of the criteria and issues is also essential to make comparable evaluations. Although it is difficult to assure homogeneous understanding with a large group of evaluators, it may be argued that a large group contributes to a balanced perspective of the issues and criteria.

The third edition of the Federal Plan for Oceanic Pollution Research, Development, and Monitoring, that for Fiscal Years 1985-1990, is due to be delivered to the Congress during September of 1985. The ranked list of issues from the national workshop will provide input to developing the priority national needs and problems identified in the Plan. The state and regional assessment provides a mechanism to ensure that the list of priority national issues adequately incorporates state and regional concerns. As such, the results of this exercise provide a view of state and regional coastal managers and academic researchers regarding the priority of marine pollution issues confronting the nation.

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FEASIBILITY STUDIES FOR REPLACEMENT OF IMPACTED WETLANDS

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INTRODUCTION

In order to obtain necessary state and federal permits for major development projects, mitigation plans for wetland takings are frequently required. From a regulatory standpoint, wetland replacement is typically required when no suitable alternative to wetland impact is available and all reasonable measures have been undertaken to minimize the disturbance. Replacement is not only be suitable for public projects but also for projects by those private developers who must also obtain a U.S. Army Corps of Engineers permit under authorization of Section 404 of the Clean Water Act.

METHODOLOGY

A wetland evaluation and feasibility study is composed of a multitude of tasks including:

1. Identification and Classification of Wetlands
2. Determination of Wetland Boundaries
3. Assessment of Wetland Functions and Values
4. Assessment of Project Impacts/Wetland Loss
5. Mitigation/Minimization of Impacts
6. Identification and Evaluation of Wetland Replacement Sites
7. Formulation of a Preliminary Wetland Replacement Plan
8. Assessment of Conversion Impacts on the Replacement Site

These are discussed in the following subsections:

Task 1 - Identification and classification of wetlands

Within New Jersey wetlands have been delineated by New Jersey Department of Environmental Protection (NJDEP), and the the United States Fish and Wildlife Service (U.S.F.W.S.) - National Wetlands Inventory (NWI). Not all areas have been mapped and in the case of NJDEP, the wetlands mapped are only those which are tidal.

All wetlands delineated by NWI and/or NJDEP and within the project area are identified and placed on project alignment drawings.

Soil surveys developed by the U.S. Soil Conservation Service (SCS) are reviewed to determine the presence and extent of hydric soils as listed by SCS. Those areas within the project area containing these soils are also mapped.

The entire project including all alternatives are walked, to ensure that all wetlands which may be impacted are taken into consideration. Our experience has shown that there are often wetlands, some relatively large, that are not mapped by NWI, and most of these are usually the palustrine type. These wetlands are also placed on project alignment drawings. On a few occasions emergent wetlands have been shown to be less extensive than that mapped by NWI. Considering the map scale and the magnitude of the task, we have found the NWI map to be a valuable tool in the initial planning stages of a project.

Wetlands verification and identification are based on the definitions provided in the next section entitled "Definition - Wetlands."

All wetlands are classified utilizing the U.S. FWS system, Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979). In the case of areas designated on NWI maps, these wetland are already classified down to subclass. Additional levels of classification are typically provided based on the results of the on-site field investigations.

Definition - wetlands

Executive Order 11990, entitled "Protection of Wetlands" (42 Federal Register, 26961, 1977) defines "wetlands" as:

> "those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds."

The U.S. Army Corps of Engineers in Federal Register, Vol. 47, No. 141 (1983), defines "wetlands" in a similar fashion, using inundated or saturated conditions and a prevalence of vegetation typically adapted for life in such conditions as the basic criteria.

The U.S. Department of the Interior, Fish and Wildlife Service in Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979) goes a step further to refine the definition of "wetlands" by assigning three important criteria. This expanded definition is as follows:

> "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, the land supports predominantly 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."

This definition introduces two important terms that are used as criteria for defining wetlands: i.e., hydrophytes and hydric soils. These terms, likewise, need to be defined. The definitions of these terms are provided by the U.S. Fish and Wildlife Service's "National Wetlands Inventory Project" (Tiner and Wilen, 1983).

A "hydrophyte" is defined by the NWI as "any plant growing in water or in substrate that is at least periodically deficient in oxygen as a result of excessive water." A listing of hydrophytes prepared by the NWI is divided into four indicator categories based on a plant's frequency of occurrence in wetlands:

1) obligate - always found in wetlands (>95% of the time)
2) facultative wet - usually found in wetlands (66-95% of the time)
3) facultative - sometimes found in wetlands (33-66%)
4) facultative upland - seldom found in wetlands (<33%)

NWI has classified hydrophytes according to these categories (U.S. FWS, 1982).

"Hydric soils" are defined by soil saturation for significant periods or by frequent flooding for long periods during the growing season. The Soil Conservation Service, in cooperation with the NWI, has prepared a listing of all soil types that are classified as "hydric."

The U.S. Fish and Wildlife Service has identified five general categories of wetland areas on the basis of the three criteria stated earlier. They are as follows:

1) areas with hydrophytes and hydric soils
2) areas without hydrophytes but with hydric soils
3) areas with hydrophytes but nonhydric soils
4) areas without soils but with hydrophytes
5) wetlands without soil and without hydrophytes

For purposes of these studies, wetlands are generally defined according to the first three criteria developed by the U.S. Fish and

Wildlife Service since they provide a means for identification of wetlands in the field. The presence of hydrophytes, however, was the most useful in identifying wetlands since that factor is the most readily observed in the field. As discussed in the methodology below, the presence of obligate species of hydrophytes (i.e., those that are found in wetlands (>95% of the time) make the delineation of wetlands easier. However, many wetlands only contain facultative species and/or hydric soils.

In addition to areas that explicitly qualify as wetlands on the basis of the three stated criteria, all ponds, streams and rivers with depths of 2 meters (6.6 feet) or less are also included. This inclusion is consistent with the U.S. Fish and Wildlife Service's differentiation between "wetlands" and "deepwater habitats." The latter term refers to permanently flooded lands lying below the deepwater boundary of wetlands where the water is too deep to support emergent vegetation (wetland obligates). The 2-meter lower limit for inland wetlands was selected by the Fish and Wildlife Service as the maximum depth to which emergent plants normally grow.

Task 2 - Determination of wetland boundaries

In order to accurately assess the acreage of wetlands impacted by the proposed project, wetland boundaries are staked in the field and surveyed. Stakes are driven into the ground at the upland most limit of wetland plants and/or the furthest extent of hydric soils, as defined in the previous task. In the case of hydric soils, core samples are taken in the field. The stakes are surveyed for both location and elevation, the latter assisting in determining the elevation contour corresponding to the wetland boundary when appropriate.

Wetland boundaries were drawn on project alignment drawings for subsequent use.

Task 3 - Assessment of wetland function and values

Several methods have been developed by various agencies in an attempt to qualify and/or quantify the values of a wetland. The USFWS have developed their Habitat Evaluation Procedures (HEP) which quantifies the wildlife value of a wetland. The U.S. Army Corps of Engineers has also developed an evaluation program which qualitatively identifies various wetland functions and values. Another system, "A Method for Wetland Functional Assessment" recently developed for the Federal Highway Administration (1982), qualitatively assesses various factors associated with the role of wetlands in the environment. With this method, the value of each impacted wetland is addressed in terms of:

- flood storage
- groundwater discharge and recharge
- fishery and wildlife habitat
- sediment trapping
- shoreline anchoring
- nutrient retention
- food-chain support
- active recreation
- passive recreation and heritage

The functional values are based on the user answering a variety of questions concerning wetland characteristics such as vegetation form, water depth, width, p_H, hydroperiod, human disturbance, etc; adjacent land characteristics, and social significance of the wetlands. These answers are then used in keys from which the value of each wetland function is rated as very high, high, moderate, low or very low.

Task 4 - Assessment of project impacts/wetland loss

Utilizing the cut and fill lines (toe of slope) designated on the project alignment maps which also depicts wetland boundaries, wetland acreage takings are calculated. Direct and indirect effects of the project are assessed, especially the loss of wetlands as it relates to functional values. In addition, adjacent wetlands can be affected by cuts via drainage of surface waters and/or lowering of the groundwater table, and the potential for these modifications is also determined.

Task 5 - Mitigation/minimization of impacts

Measures for mitigating and/or minimizing impacts are evaluated. In the case of wetlands directly lost, replacement is the most commonly used type of mitigation. For impacts on adjacent or downstream wetlands, measures to insure an adequate water supply during and after construction are recommended.

Task 6 - Identification and evaluation of wetland replacement sites

Utilizing existing maps, especially U.S. Geologic Surveys, and aerials, potential replacement sites are identified. Criteria for selection of sites include: 1) being in close proximity to impacted wetlands, or at least in the same watershed, 2) having a low existing natural value, 3) having an adequate water supply, 4) being of suitable size and 5) other project specific criteria such as the amount of material to be excavated and disposed.

Each site is visited to determine its character. Selected sites are then ranked according to their suitability. Sites are compared as to the above criteria, current value to wildlife, the adjacent land-use, the ease of conversion to a wetland and other characteristics of the sites.

Task 7 - Formulation of a preliminary wetland replacement plan

The ratio of wetland acreage to be replaced to the acreage lost is dependent on the wetlands characteristics, and the requirements of the regulatory agencies involved.

For the most suitable site a preliminary wetland replacement plan is developed. The plan includes suggested vegetation to be planted, site configuration, water depth or extent of soil saturation, site topography, the portions of the site to be devoted to each wetland type (in the case of diverse wetlands) and other engineering requirements, especially those necessary to create the desired water depth/soil saturation and to stabilize the newly created wetland.

The functional values of the replacement site after conversion to a wetland, are assessed based on the proposed plan. These values can then be compared with that of the lost wetlands to determine if the replacement provides adequate mitigation.

Task 8 - Assessment of conversion impacts on the replacement site

The impact of conversion of the replacement site to a wetland is assessed. Recognizing that the modification of an existing area to create wetlands may result in a corresponding loss of other natural values, it is important to find a site which is currently unproductive or severely disturbed. However, in many situations, this type of area is difficult to locate, particularly if the replacement obligation involves a large acreage. Another factor that has to be considered in selecting the site is the amount and type of material to be excavated, as sites for disposing of unsuitable material are also difficult to locate. Similarly, the costs associated with disposing of excavated material which cannot be used for fill on other construction projects can be quite high.

In some situations, particularly involving large acreages, the conversion of an existing non-wetland site to wetlands can be adversely received by the affected municipality. Most municipalities are concerned with the loss of future developable properties and tax ratables associated with the conversion of a large parcel to wetlands.

Summary

The construction of new wetlands to replace those impacted by development requires an analysis of a variety of issues to develop a mitigation plan that provides a net ecological benefit. Although only briefly discussed in the paper, there are several important factors beginning with the identification of an affected wetland, followed by the evaluation of alternatives to avoid the impact and the development of measures to minimize the the effect that must be carefully considered in planning an acceptable project. Several methods have been recently developed to evaluate wetland functions and values, and because of the complete range of factors considered, the FHWA procedure has been found to be quite useful in the initial planning process. If wetland takings cannot be avoided then development of a mitigation plan has merit, which usually involves replacement of affected wetlands. However, this plan must also consider several issues if there is to be a net benefit to the environment, and to insure that the plan can be economically implemented.

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ARTIFICIAL VERSUS NATURAL TIDAL SALT MARSHES: ARE ARTIFICIAL MARSHES EQUIVALENT FOR MITIGATION ?

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Introduction

During the period 1953 to 1973 the State of New Jersey lost approximately one quarter of its coastal tidal wetlands to human development through filling and dredging activities (Ferrigno et al. 1973). As the scientific community studied coastal estuarine ecosystems, the important role and function of the tidal wetlands became apparent (Teal 1962, de la Cruz 1973). Concern for the conservation and protection of these wetlands increased and lead to the enactment of legislation. In New Jersey, the Wetlands Act of 1970 (NJSA 13:9A-1) was passed with the goal of stopping the destruction and loss of our valuable coastal tidal wetlands.

In order to develop biologically valuable coastal habitats and minimize adverse impacts, various organizations and coastal management programs have turned to concept of "mitigation". The basic idea of mitigation is to compensate for adverse impacts and damages from human development activities on natural ecosystems through habitat rehabilitation or creation. The term "mitigation" is not well defined in an environmental sense and varies with the subject of the text or article (Race and Christie 1982). Some people view mitigation as an attempt by developers to destroy natural wetlands while other people view mitigation as an attempt by management to improve or enhance degraded wetlands.

One key question concerning the concept of mitigation is whether or not the man-made habitat (artificial marsh) is "equivalent" to the destroyed natural habitat (natural marsh) (Race and Christie 1982). In other words, does the artificial marsh biologically compensate for the loss of the natural marsh? Few scientific studies have addressed this question or examined artificial marshes in a vigorous scientific manner. In order to evaluate past artificial salt marshes in New Jersey the Department of Environmental Protection, Division of Coastal Resources contracted with the authors to examine past artificial marsh projects. The overall objectives of the study was to a) evaluate the artificial marshes for their effectiveness in developing into productive marshes, b) compare sediment characteristics of artificial marshes with natural marshes, and c) develop a set of guidelines concerning artificial marshes for utilization in the New Jersey coastal zone management program.

The results of our investigation are reported in the New Jersey Agricultural Experiment Station Publication Number P-40502-01-84 submitted to the Division of Coastal Resources. Details of our research may be obtained from this report. The objective of this paper is to discuss the basic question: Are artificial (man-made) salt marshes "equivalent" to natural salt marshes?

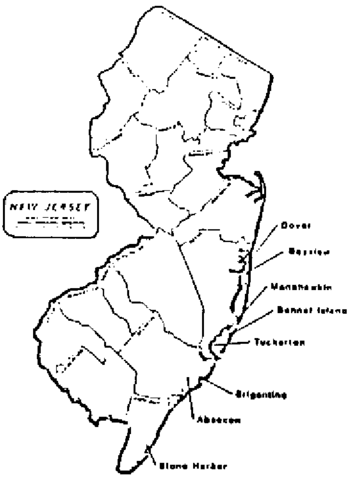

Figure 1. Location of study sites in New Jersey.

Study Sites and Methods

Eight past artificial marsh projects were selected for quantitative analyses (Table 1 and Figure 1) from thirty known artificial marsh projects in New Jersey. The sampled marshes were characterized by a) having information concerning the methods used to construct the artificial marsh, b) vegetation (*Spartina alterniflora* and/or *S. patens*) was present on most of the artificial marsh, and c) the age of the artificial marsh was two years or older. A natural marsh adjacent to the artificial marsh was also selected for sampling. The same major vegetation found in the artificial marsh was sampled in the natural marsh.

Variables measured at each sampled artificial and natural marsh focused on the major vegetational species and sediment. Vegetational parameters measured were standing crop biomass (per 0.0625 m2) (live and dead), percent of live to dead biomass (%), density (per 0.0625 m2), height (cm), stem diameter (cm), and the number of reproductive heads. Sediment characteristics which were measured included pH, magnesium (ppm), phosphorus (ppm), potassium (ppm), calcium (ppm), sodium (ppm), nitrogen (ammonium form) (ppm), organic matter (%), and electrical conductivity (mmhos/cm). Values obtained from the artificial and natural marshes were statistically compared by a series of T Tests and analysis of variances (Zar 1974). An alpha level of 0.05 was chosen to determine whether there was a significant difference between the artificial and natural marsh for a given variable.

Table 1. Common characteristics of the sampled artificial marshes. Type=classification of the artificial marsh project (CR=creation and RT=restoration). Acreage=approximate size of the artificial marsh. Net Acreage=net gain of wetlands (destroyed marsh surface minus artificial marsh acreage). Sediment=type of soil used for the artificial marsh (dredge=dredge spoil, natural=marsh peat, and inorganic=sand). Species planted=vegetation planted in the artificial marsh (SA=*S. alterniflora*, SP=*S. patens*, and vol.=natural colonization and revegetation).

Name	Type	Acreage	Net Acreage	Sediment	Species Planted	Date Planted
A-Brigantine	CR	0.8	-0.15	dredge	SA	7/1981
B-Stone Harbor	CR	1.6	-	natural	vol.	-
C-Bayview	RT	0.15	0.0	inorganic	SA	10/1977
D-Absecon	RT	0.02	0.0	inorganic	SP	8/1981
E-Manahawkin Bay	RT	1.0	0.0	inorganic	SP	1977
F-Bonnet Island	RT	2.5	0.0	inorganic	SA/SP	1977
G-Tuckerton	RT	1.6	0.0	inorganic	SP	1977
H-Dover	RT	0.12	-0.77	inorganic	SA/SP	1978

Results and Discussion

The first artificial (man-made) marshes scientifically evaluated were in North Carolina where *S. alterniflora* was planted on dredge spoil islands. Cammen (1976) and Seneca et al. (1976) found that the above ground biomass was comparable to the natural marshes but below ground biomass was different. Below ground biomass was higher in the natural marsh. They demonstrated that there were vegetative differences between artificial and natural marshes.

In our study, certain vegetative characteristics of the artificial marshes were statistically similar to the natural marshes while others were significantly different (Table 2 and Figure 2). Overall, the height, percent of live to dead biomass, and live biomass were statistically similar between the eight artificial and adjacent natural marshes. Dead biomass, total biomass, density and the number of reproductive heads were significantly different between the artificial and natural marshes.

Table 2 represents the comparisons (T Test) of individual artificial and adjacent natural marshes while Figure 2 represents an overall analysis (analysis of variance) of the eight study sites. The individual marsh comparisons revealed that certain artificial marsh projects (A,C, and F) were vegetatively similar to the adjacent natural marsh while other artificial marsh projects (D,E,G and H) were dissimilar in many respects (Table 2). The analysis of variance of the eight artificial marshes and their associated natural marshes showed that density, number of reproductive heads, total biomass and dead biomass were significantly lower in the artificial marshes (Figure 2). Artificial marshes had significantly lower total biomass indicating that the productivity of artificial marshes was lower (not

Table 2. Summary table of a series of T Tests of the vegetation variables of the artificial and natural marshes. The letters A-H represent the eight study sites (see Table 1). The symbols indicate the results of the T tests; a "=" indicates that there was no significant difference between the artificial and natural marsh, a "+" indicates that the mean of the artificial marsh was significantly higher than the natural marsh, and a "-" indicates that the mean of the artificial marsh was significantly lower than the natural marsh.

Variable	A	B	C	D	E	F	G	H
DENS	=	=	=	-	-	=	-	-
VERT	=	-	+	+	-	+	-	-
HEAD	=	=	+	-	=	=	=	-
PERC	=	=	+	=	-	=	-	-
LB	=	=	=	-	-	=	-	-
DB	=	-	-	-	=	=	=	-
TB	=	=	=	-	=	=	-	-

Table 3. Summary table of a series of T Tests of the sediment variables of the artificial and natural marshes. See Table 2 for an explanation of the table.

Variable	A	B	C	D	E	F	G	H
pH	=	+	=	-	=	=	=	=
Mg	=	-	-	-	-	=	-	-
P	=	=	=	=	-	=	=	=
K	=	-	-	-	-	=	=	=
Ca	=	+	-	-	-	=	=	-
N	=	=	=	=	-	-	-	-
Org	=	-	=	-	-	-	-	-
Na	=	-	-	-	-	-	-	-
Elec	=	=	-	-	-	=	-	-

equivalent) compared to the natural marshes. The low amount of dead biomass in the artificial marshes accounted for the difference in total biomass since live biomass was similar between the artificial and natural marshes.

One important factor recognized in the development of artificial marshes is the type of sediment used. In a controlled greenhouse environment, Smart and Barko (1978) revealed that the type of sediment had a large affect on the productivity of marsh vegetation. Cammen et al. (1974) showed that the physical nature of the sediment in certain artificial marshes influenced the type of fauna which invaded and colonized the marsh.

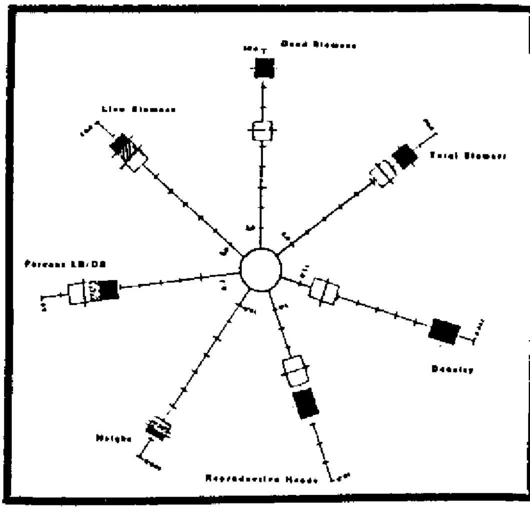

Figure 2. Summary diagram of the vegetation variables of the eight study sites. The boxes represent the mean (middle line) ± the least significant interval. Overlap (not significantly different) of the boxes is indicated by the cross hatching (black boxes=natural marshes, white boxes=artificial marshes).

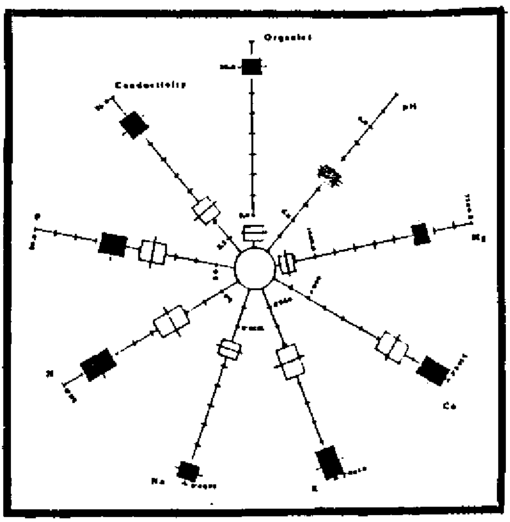

Figure 3. Summary diagram of the sediment variables of the eight study sites. See Figure 2 for description.

The sediment characteristics of the eight artificial marshes we studied were very different from the adjacent natural marshes. A series of T Tests revealed that most artificial marsh sediments had significantly lower values of the measured variables compared to the adjacent natural marsh (Table 3). In the analysis of variance all of the measured variables (except pH) were significantly lower in the artificial marshes compared to the natural marshes (Figure 3). The mean percent of organic matter was six times higher in the natural marshes. Electrical conductivity (an indicator of salinity; 1 millimho = 640 ppm) was very low in the artificial marshes. Nutrients for good plant growth were also significantly lower in the artificial marshes compared to the natural marshes.

Our data suggests that many measured vegetative and edaphic (sediment) variables were significantly lower in the artificial marshes compared to adjacent natural marshes. Overall, the productivity (biomass/standing crop) of the artificial marshes was significantly lower. Density of the vegetation was lower in artificial marshes suggesting that vegetative growth and/or seedling establishment is not occurring even after vegetative planting of the artificial marsh. Sediments were very different with artificial marshes having very low values compared to the natural marshes. This result was a function of the sediment used in the construction of the artificial marshes (mostly sand) and the characteristics of natural marsh sediment (peat). Present day natural marshes have taken many hundreds of years to develop (Redfield 1972).

Our results indicate that the overall answer to the question "Are artificial marshes equivalent to natural marshes?" is NO. Many characteristics of the artificial marshes were lower than the natural marshes. Artificial marshes appeared to be biologically different. In view of the concept of mitigation, artificial marshes are not equivalent to natural marshes and therefore are not a biologically equivalent replacement of a natural marsh.

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TRANSGRESSION AND VEGETATION CHANGE, DELAWARE BAY, NEW JERSEY

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Introduction

Field studies along the Delaware Bay shoreline of New Jersey show that in many areas the dominant shore zone vegetation is Phragmites australis, or common reed. Though this plant is widespread in the state, its dominance of shoreline plant communities is surprising. Salt marsh environments such as those around the Delaware Bay in Cumberland County, N.J. (the study area), are typically dominated by several species of Spartina (Silberhorn, 1982). Along bay fringe marshes and tidal creeks and rivers, S. alterniflora, salt marsh cord grass, tends to dominate the intertidal zone. Just above the mean high water mark, S. patens (salt meadow hay) and other species such as Distichlis spicata (spike grass) and Iva frutescans (marsh elder) are dominant. Though there have been no detailed studies of shoreline vegetation along the New Jersey side of Delaware Bay between the Cape May peninsula and the lower Delaware River, general references and regional environmental inventories have all listed Spartina alterniflora as the dominant marsh fringe vegetation (Robichaud and Buell, 1973; Walter, et al, 1981; Walton and Patrick, 1973).

Yet fieldwork in 1983-84 found relatively few Spartina-dominated shorelines. Rather, Phragmites often dominated not only on sandy and developed shores, but on marsh fringes. Monostands of Phragmites were found in remote shoreline reaches with no evidence of human disturbance. If vegetation change has occurred naturally, perhaps as a result of sea level rise, this implies that plant communities and marsh zonation may change during transgression.

Background

Phragmites australis is ubiquitous in New Jersey wetlands as an invader of disturbed sites. The biology of the reed is reviewed in detail by Howard, Rhodes, and Simmers (1977). Phragmites is a rapid colonizer of wet, disturbed sites, but rarely invades established plant communities. Its occurrence in New Jersey is typically indicative of disturbance, and it is widely found on spoilbanks and in roadside ditches (see Sipple, 1971).

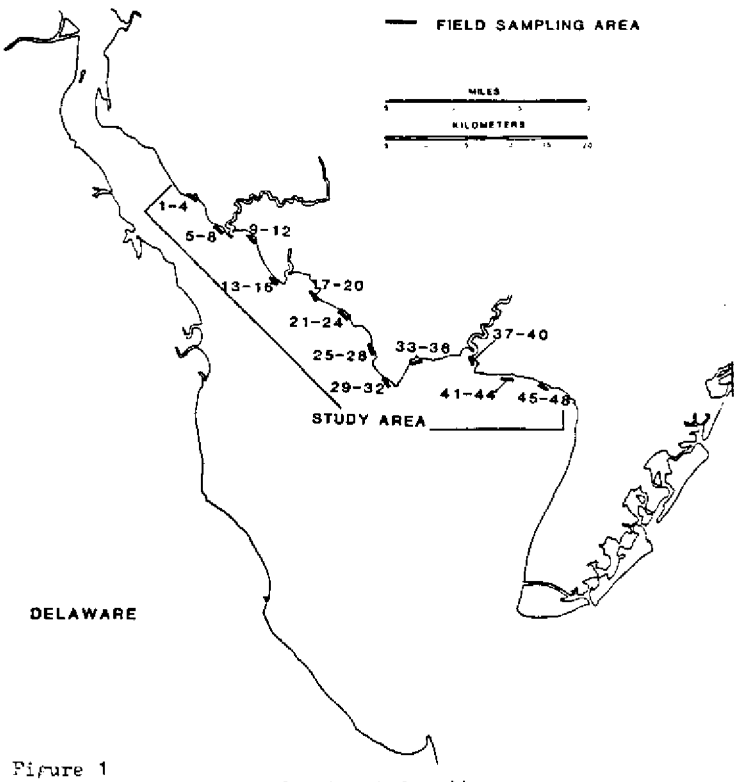

Figure 1
Study area. Numbers refer to study sites.

Detailed studies of marsh vegetation have been carried out near the study area. Good (1965), in a study of the Goshen Creek marsh in Cape May County, recorded Phragmites at the upland-marsh boundary and in filled-in portions of the creek. It did not occur along the bayshore or undisturbed portions of the creek bank. In the Oldman's Creek tidal marsh off the Delaware River, McCormick and Ashbaugh (1972) did not find Phragmites to be an important component of the freshwater marsh. Nearly pure stands existed on nearby moist uplands, but several other species were associated with the reeds in the marshes. Walton and Patrick (1973), who inventoried the entire Delaware estuary, also note the species chiefly in areas disturbed by ditching and channelization throughout the region.

While studies elsewhere in southern New Jersey (Ferren, et al, 1981) have shown that Phragmites can radiate into neighboring vegetation types by rhizome extension, they found that initial colonization still required some disturbance. In Connecticut salt marshes, Phragmites invasion was found to coincide with tidal restrictions which lowered the water table and soil salinity (Roman, et al, 1984). In short, the common reed will quickly invade moist areas that have been disturbed and is persistent once established, but will not usually become established in undisturbed, healthy plant communities (Howard, et al, 1977). Though the species is common in disturbed areas of coastal marshes, in freshwater wetlands, and near the wetland/upland interface, it has not been thought to be a natural component of undisturbed shoreline fringe marshes.

Phragmites Distribution

Forty-eight shoreline study sites, arranged in a four-stage nested sampling design, were established in the study area (Figure 1). At each site shore-normal transects were established from the high salt marsh or just above the mean high water mark to low tide wading depths. The transects were sampled during the period November, 1983-March, 1984. At each site data on elevation, morphology, and soils were collected. Each plant species present in a one-meter band along the transect was identified, and ground cover estimated for each stand or subenvironment using the Braun-Blanquet scale and methods detailed by Kuchler (1967).

Of the 48 sites, eight were unvegetated (all developed or disturbed sites). Of the 40 vegetated sites, Phragmites australis was present at 27 sites, and was classified as the dominant vegetation at 21 sites. Of those 21 sites, two had obviously been disturbed by human activity. Two other sites appeared undisturbed, but were in close proximity to bayshore settlements and may have been influenced by human activity. There was no evidence of disturbance at 17 of the sites where Phragmites dominated shoreline vegetation. Of the 19 undisturbed or apparently undisturbed sites, 11 were marsh fringes with no beach and eight were shorelines with sand barriers. Overall, Phragmites was by far the most common of the 11 species identified in the shoreline zone, with Spartina alterniflora the dominant at only 14 sites.

Clearly, Phragmites australis is an important component of the shoreline fringe vegetation. Because water salinity regimes are saltwater or brackish throughout the study area (Walton and Patrick, 1973; Walter, et al, 1981) and there is no evidence of disturbance at many sites, this fact is puzzling. How did the reed become established at these sites? Field evidence suggests two modes of Phragmites colonization, both associated with rising sea level.

Models of Phragmites Colonization

The first model holds that sand deposition on marsh surfaces and barrier transgression are the mechanisms enabling Phragmites australis to colonize the marsh fringe. Delaware Bay is a transgressive system. As sea level rises, the marshes and coastal wetlands "climb" the pre-Holocene uplands even as the bayward shoreline retreats. A series of transgressive models and sequences have been developed for Delaware Bay by John Kraft and his associates and students at the University of Delaware (Kraft, 1971; Kayan and Kraft, 1979; Kraft, et al, 1976; Maurmeyer, 1978; Weil, 1977; Washburn, 1982). Part of the transgressive process is the landward migration of sand barriers over the salt marsh. As these sand bodies encroach on the salt marsh, they represent a disturbance, destroying the existing vegetation (presumably Spartina) and creating an opportunity for Phragmites australis colonization. Phragmites is the dominant vegetation at the majority of the sandy study sites and is present at all sand barrier study sites.

Sand barriers may be temporary, occurring seasonally or being deposited (and subsequently removed) during storms. It is not uncommon for a sand barrier to be transient along the bayshore if a constant supply of coarse-grained material is not available (Maurmeyer, 1978). If the disturbance lasts long enough for Phragmites to become established, the species would remain in place as the dominant species of the fringe marsh. Though limited by salinity and tidal saltwater flooding (Roman, et al, 1984; Bird, 1963; Howard, et al, 1977), the species is typically highly productive. Rapid peat formation seems to enable the reed to elevate itself above most tides. Where no sand exists, however, determination of the role of sand deposition in allowing Phragmites establishment is problematic, because even semi-permanent Delaware Bay barriers are often not preserved in the stratigraphic record.

The model of reed colonization due to sand barrier transgression is shown in Figure 2.

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1. Sand is deposited on, or transported over, Spartina marshes.
2. Spartina is suppressed or destroyed.
3. Phragmites australis colonizes sandy area.
4. If sand barrier is removed or transported further inland, Phragmites may remain as marsh fringe vegetation.

FIGURE 2. Establishment of common reed during estuarine barrier transgression.

The association of sand and Phragmites along the bayshore is sometimes dramatic—at several locations, it was observed that marshy headlands were dominated by Spartina alterniflora, while the intervening sand-veneered cove was dominated by Phragmites. Still, the occurrence of the reed as a dominant on a number of marsh fringe shorelines with no apparent source of sand nearby indicates there may be other means of colonization.

Godfrey and Godfrey (1975) described a cyclic sequence of development in Spartina alterniflora marshes behind barrier islands. The model described below and shown in Figure 3 is an adaptation of the Godrey model.

Once a Spartina alterniflora marsh has become established, the combination of inorganic sediment deposition and biomass production often allows peat accumulation to keep pace with sea level rise. If sedimentation rates exceed the rate of local coastal submergence, the Spartina marsh surface may build to the level of mean high water. At this

1. Establishment of Spartina alterniflora marsh

2. Marsh peat accumulates at a rate exceeding the rate of sea level rise.

3. Marsh surface is elevated to the level of mean high water.

4. Phragmites australis invades marsh surface.

5. Bayside erosion truncates shoreline below mean high water mark, eliminating S. alterniflora. Wave attack of marsh scarp inhibits recolonization.

6. Phragmites remains as dominant shoreline vegetation.

FIGURE 3. Establishment of common reed on estuarine marsh shorelines.

point other species, such as Phragmites australis and Iva frutescans may invade. If, as often happens in Delaware Bay, severe erosion truncates the intertidal shoreline, creating a scarped profile below mean high water, intertidal vegetation such as S. alterniflora may be eliminated and recolonization inhibited. Phragmites australis would be left as the dominant vegetation.

Discussion

Phragmites australis has undeniably become a major component of the marsh fringe vegetation of Delaware Bay. It also seems clear that the species often succeeds Spartina alterniflora. At marsh scarps at eight sites it was observed that under the Phragmites peat was a thick layer of Spartina alterniflora peat. This was also true for shallow auger cores taken at three other sites. The lack of human disturbance at many of these sites indicates that this vegetation change is the result of natural processes.

Two geomorphological responses to sea level rise--sand barrier transgression, and marsh surface accretion and bayside profile truncation--seem to provide mechanisms enabling Phragmites to establish itself in bayside marshes.

Transgressive models have assumed that the sequence of geomorphic and ecological units from estuary to upland remains intact, even though the location of the entire system shifts upward and landward. Evidence from Delaware Bay indicates that this may not be the case; that the character as well as the location of coastal wetlands may be changed as sea level rises.

Much more study into estuarine shoreline processes, the interaction between vegetation and geomorphic processes in coastal wetlands, and the stratigraphy of tidal marshes is needed to confirm the suggestion above. The observed vegetation change of the New Jersey bayshore may not be significant in the long term. Evidence is strong enough, however, to warrant further study.

Conclusions

Phragmites australis has become the dominant shoreline vegetation along much of New Jersey's Delaware Bay shore. This is true in many remote areas where there has been no human disturbance, usually necessary for colonization of the species. It is suggested that two natural geomorphic responses to rising sea level enable the species to establish itself in fringe marshes: (1) Transgression of sand barriers, and (2) Accretion of marsh surfaces, accompanied by erosional truncation of the bayside profile. This implies that the basic character and vegetative composition of coastal wetlands may be altered during the period of rising sea level.

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Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ.

ARTIFICIAL SALT MARSH STABILITY: A GAMBLE WITH THE SHORE

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Division of Coastal Resources
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The loss of wetlands through natural and artificial means is a significant problem which can result in a deleterious effect on the ecological balance between man and nature. The artificial use of salt marsh can be a useful alternative when mitigating the impact of development on or near wetlands. The most appreciable wetland losses have been attributed to main's presence, in New Jersey over 65,000 acres of marsh loss occurred between 1953 to 1971 (DEP Wetlands Study, 1979). Natural marsh erosion occurs as a result of wave action contacting the toe of the vertical wetland slope causing it to become unstable thereby collapsing (Sharp, Belcher and Oyler).

Salt march stability occurs as natural deposition of alluvial material becomes trapped along the toe of the marsh. This accretion process affords the adapted vegetation an opportunity to propagate thereby increasing the wetland habitat (Smith, 1980). Once established, the wetlands provide the adjacent upland with additional protection from erosion (Garbish). Wetlands provide a transition zone between the upland and the sea, dissipating wave action and acting as flood storage area. The wetlands trap sediment and water contaminants which would otherwise add to pollution.

The ecological importance of wetlands as a basis of the marine flood web has been well documented. Bacteria and protozoa are dependent upon the decomposing plant material, detritus, which is indigenous to the wetlands. Larger invertebrates feed upon the bacteria and protozoan and the biological process is continued by shellfish, finfish and waterfowl which in turn are fed upon by man.

The beauty and productivity of salt marsh is easily appreciated by those who understand them. The benefits from the Wetlands are enormous and deserve preservation. As a result of the significant losses of Wetland areas the New Jersey State Legislature drafted the Wetlands Act of 1970. This Act required the Department of Environmental Protection (DEP) to inventory and map lands meeting the specified definition of wetlands. Since the inception of the Act there has been progressively fewer wetlands destroyed, in fact between 1973 thru 1982 only 409 known acres of wetlands have been lost.

According to Coastal Resource Policy, development of all kinds is prohibited in wetlands unless the DEP can find that the proposed development meets the following four conditions:

1. Requires water access or is water oriented as a central purpose of the basic function of the activity,

2. Has no prudent or feasible alternative on a non-wetland site.

3. Will result in minimum feasible alteration or impairment of natural tidal circulation and,

4. Will result in minimum feasible alteration or impairment of natural contour or the natural vegetation of the wetlands.

One of the early projects successfully incorporating the use of salt marsh for shoreline stabilization in New Jersey is Brigantine Land Improvement. The project design was consistent with the Coastal Resource Policies and mitigation was required to compensate for the alteration of 1.12 acres of regulated Wetlands. The applicant originally contemplated the construction of a continuous bulkhead; however, the proposal was later revised as a result of the permit process to utilize marsh establishment. It was the applicant's intention to stabilize the existing shoreline and protect it from erosion (See attached plan).

The project site is located on Saint George's Thorofare otherwise known as Half Moon Inlet. The area was created by dredging in the mid 1960's. The applicants plan provided for the construction of approximately 1,120 linear feet of timber bulkhead in an "L" shape. As a result of DEP input the proposal was revised to allow for the creation of a wetland plateau which was vegetated with salt marsh, more specifically Spartina alterniflora species. The bulkhead aspect was modified with a slope revetment system which facilitated the marsh creation.

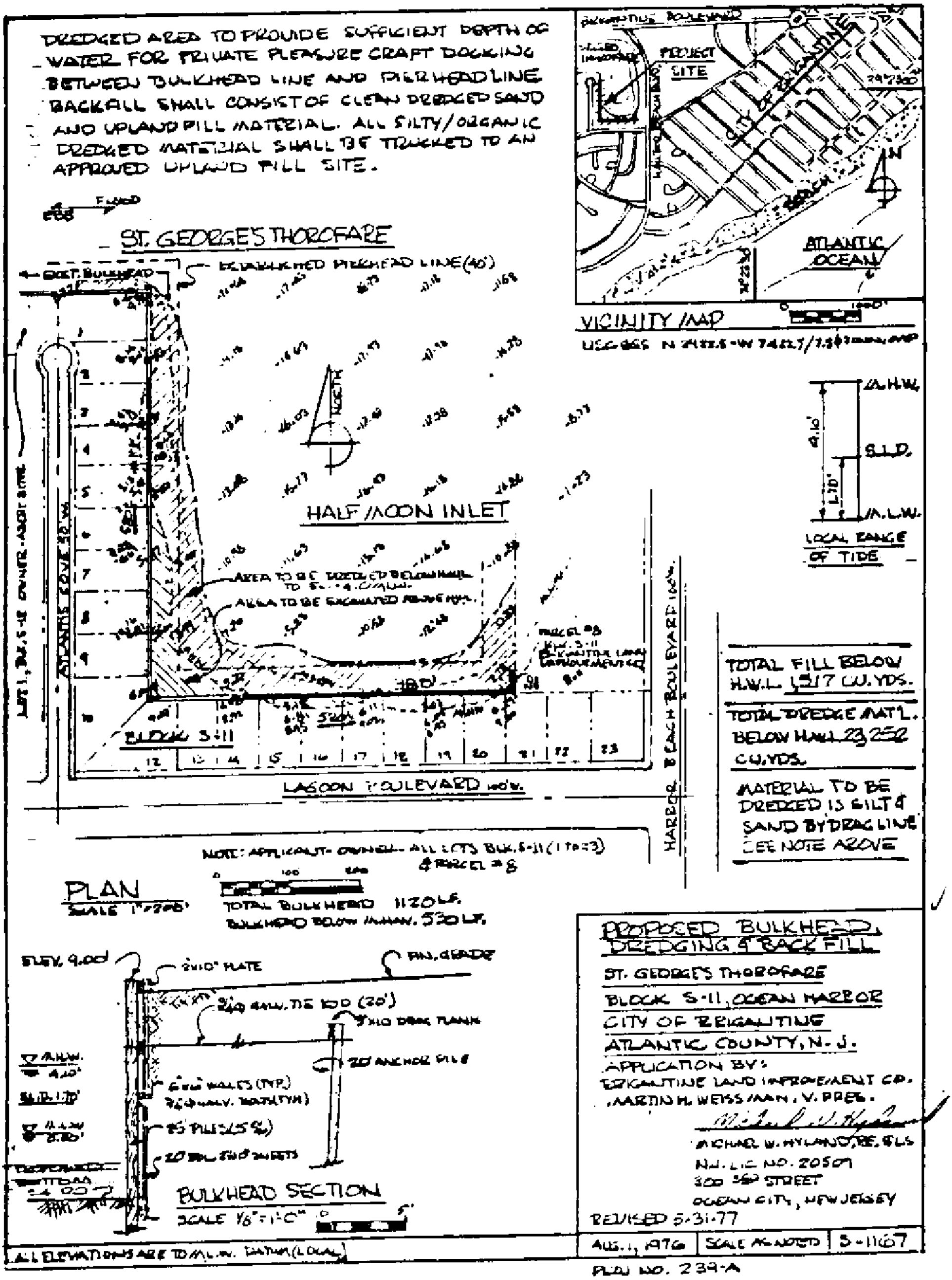
To create a coastal marsh artificially the proposed site must be evaluated based on the geographic area, tidal elevation, salinity, fetch length, and soil properties. The Brigantine Land Improvement site contained the favorable environmental conditions conducive to marsh establishment. The artificial use of wetlands for shoreline stabilization has been successfully completed by Dr. Edward Garbish and he was contracted to perform the work on the case study. According to Garbish, the basic objective of any approach to shore erosion control is to eliminate or minimize the contact time of the water with the face of the eroding bank.

The Brigantine Land Improvement project stabilized the shoreline with a slope revetment using Gobi blocks which are donut like individual units weighting approximately 13 pounds each. The Gobi blocks are interlocked and placed over a filter fabric or mat. There are other methods and materials available which could perform a stabilization function; however, the applicant chose Gobi mat because of economics, the Gobimat system absorbs and dissipates the wave energy generated by tidal waters.

The main feature of this application was the creation of salt marsh along a 24' plateau area. Gobi blocks were placed at the toe of the plateau to stabilize the edge of the marsh and protect it form erosion. Gobimats were utilized along the slope to provide upland stability. The project engineer determined the proper elevation of the plateau this was a critical aspect of the project because the spartina alterniflora (high vigor) required daily tidal inundation.

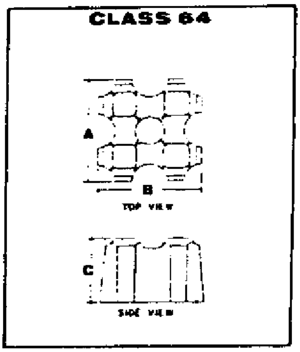
This project demonstrated the successful use of salt marsh in concert with a slope revetment. However, there are some negative qualities worth mention. The slope stabilization approach can only be used when there is sufficient land to meet the requirements. A typical bulkhead does not require much upland property and is a proven method. On this project the ice lifted many of the Gobi blocks and vandalism resulted in an appreciable loss of blocks.

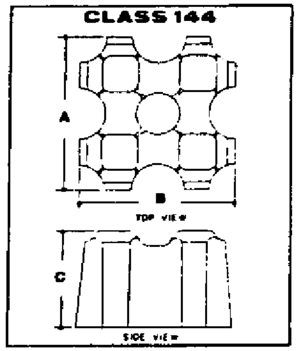
The salt marsh stability which occurred on project was significant and has resisted erosion very well. This site is relatively sheltered and is not subject to extreme wave action which would limit the success of the marsh establishment. The planning expense was high and the permit process required much thought and input by many agencies. However, the Wetlands serve as an excellent habitat.

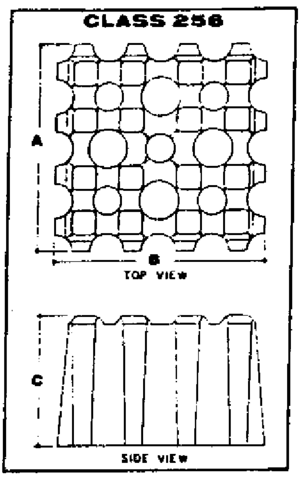

DREDGED AREA TO PROVIDE SUFFICIENT DEPTH OF WATER FOR PRIVATE PLEASURE CRAFT DOCKING BETWEEN BULKHEAD LINE AND PIERHEAD LINE. BACKFILL SHALL CONSIST OF CLEAN DREDGED SAND AND UPLAND FILL MATERIAL. ALL SILTY/ORGANIC DREDGED MATERIAL SHALL BE TRUCKED TO AN APPROVED UPLAND FILL SITE.
FLOOD
EBB
ST. GEORGE'S THOROFARE
EXIST. BULKHEAD
ESTABLISHED PIERHEAD LINE (40')
NORTH
HALF MOON INLET
AREA TO BE DREDGED BELOW MHW
AREA TO BE EXCAVATED ABOVE MHW
PARCEL #8
BLOCK S-11
ATLANTIS COVE
LAGOON BOULEVARD
HARBOR BEACH BOULEVARD
NOTE: APPLICANT-OWNER- ALL LOTS BLK. S-11 (1 TO 23) & PARCEL #8
PLAN
SCALE 1"=200'
TOTAL BULKHEAD 1120 L.F.
BULKHEAD BELOW M.H.W. 530 L.F.
VICINITY MAP
PROJECT SITE
BRIGANTINE BOULEVARD
CITY OF BRIGANTINE
ATLANTIC OCEAN
M.H.W.
S.L.D.
M.L.W.
4.10'
1.10'
LOCAL RANGE OF TIDE
TOTAL FILL BELOW H.W.L. 1,517 CU.YDS.
TOTAL DREDGE MAT'L. BELOW M.H.W. 23,252 CU.YDS.
MATERIAL TO BE DREDGED IS SILT & SAND BY DRAG LINE SEE NOTE ABOVE
ELEV. 9.00'
2"x10" PLATE
FIN. GRADE
3/4" GALV. TIE ROD (20')
3"x10" DRAG PLANK
20' ANCHOR PILE
M.H.W. 4.10'
S.L.D. 1.10'
M.L.W. 0.00'
BULKHEAD SECTION
SCALE 1/8"=1'-0"
ALL ELEVATIONS ARE TO M.L.W. DATUM (LOCAL)
PROPOSED BULKHEAD, DREDGING & BACK FILL
ST. GEORGE'S THOROFARE
BLOCK S-11, OCEAN HARBOR
CITY OF BRIGANTINE
ATLANTIC COUNTY, N.J.
APPLICATION BY:
BRIGANTINE LAND IMPROVEMENT CO.
MARTIN H. WEISSMAN, V. PRES.
MICHAEL W. HYLAND, P.E., P.L.S.
N.J. LIC. NO. 20509
300 36th STREET
OCEAN CITY, NEW JERSEY
REVISED 5-31-77
AUG. 1, 1976
SCALE AS NOTED
S-1167
PLAN NO. 239-A

Dimensions & Weights

GOBIMAT® grids







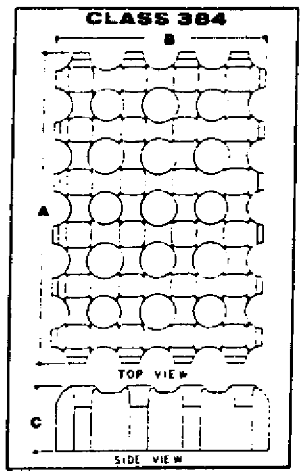


TABLE 1.0	GOBIMAT TECHNICAL DATA
SPECIFIC WEIGHT (γ), LBS./CU FT.	130-140
COMPRESSIVE STRENGTH LBS./SQ. IN	4000-5000
ABSORPTION %	8
FREEZE THAW	NO VISIBLE EFFECT

TABLE 2.0 GOBIMAT GRIDS

CLASS	NOMINAL DIMENSIONS			GROSS AREA/ GRID SQ. FT.	WEIGHT/ GRID LBS	WEIGHT/ SQ. FT LBS	OPEN AREA
	A	B	C				
64	8"	8"	5"	0.44	15-16	34.1-36.4	35%
144	12"	12"	7.5"	1.00	50-55	50.0-55.0	35%
256	16"	16"	10"	1.77	120-130	67.8-73.4	35%
384	24"	16"	5"	2.67	90-96	34.1-36.4	35%

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MITIGATION OPTIONS RELATED TO PORT DEVELOPMENT FOR FISH AND WILDLIFE RESOURCES IN TAMPA BAY, FLORIDA

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Introduction

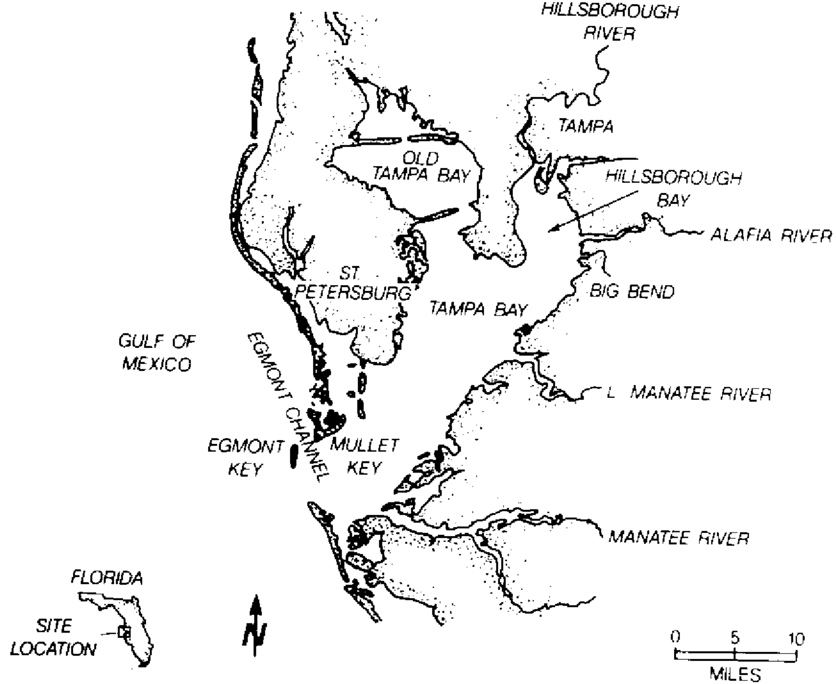
For several years, there has been an evolving effort among local agencies and individuals to develop a better understanding of the environmental problems of Tampa Bay, Florida (Figure 1), and to develop an overall strategy for improving and protecting the bay's resources. Starting as information discussions among local scientists, this effort resulted initially in a week-long symposium (Bay Area Scientific Information Symposium, May 1982) where local scientists attempted to consolidate the existing knowledge about the bay in more than 40 subject areas.

During the symposium, it became apparent that there was a broad-based concern over the lack of a regional strategy for improving the bay or managing its resources. Participants decided to establish a program through the Regional Planning Council to develop such a strategy. With funding from a Coastal Zone Management grant, a Regional Bay Study Committee was established. The committee spent almost a year identifying and assessing the relative importance of perceived problems in the bay. A corollary effort to identify solutions to these problems was unsuccessful.

The Tampa Port Authority (Authority) has been an active participant in these activities from the beginning. As the owner of a large portion of the bay bottom and as a local regulatory agency for marine construction, the Authority will play a role in the implementation of any bay improvement strategy. In addition, a significant portion of past dredging and filling activities, which have greatly altered the shoreline and the historic natural habitat of the bay, has been associated with projects either sponsored or conducted by the Authority and other port-related industries.

Figure 1.

GENERAL LOCATION MAP OF TAMPA BAY.
PORT OF TAMPA IS LOCATED IN HILLSBOROUGH BAY.



The Regional Bay Study Committee identified two priority needs that relate directly to the port's long-term development potential. These are a long-term, bay-wide strategy for disposal of dredged material and an overall plan for mitigating the environmental impacts of future dredging projects. The latter need attracted the attention of the United States Fish and Wildlife Service (FWS) in late 1982.

The FWS and the Authority entered into a Cooperative Agreement in Summer 1983 to develop a factual basis and alternatives analysis for the bay, which might also be used as prototype for future agreements between the FWS, the Authority, and possibly other agencies. The specific objectives of the Agreement were (1) to identify management and mitigation options that will allow development and maintenance of the Port of Tampa to proceed in an environmentally acceptable fashion, (2) to develop an information base in mapped and text-tabular formats for analyzing and evaluating mitigation and management options, and (3) to develop a management plan to guide the Authority in the development and maintenance of the port.

Study Tasks

Five major study tasks must be completed to accomplish these objectives: (1) prepare 1:24,000-scaled wetland, seagrass, and land-use maps for the 1956, 1972, and 1978, (2) prepare 1:24,000-scaled environmental atlas depicting biological and physical characteristics, (3) develop a geographic information system (GIS) for mapped data, (4) prepare a synthesis document (estuarine profile) on the ecology of the bay, and (5) prepare a mitigation options document.

Mapped Information

FWS and the Authority will prepare wetland, seagrass, and land-use maps for 1956, 1972, and 1982 at a scale of 1:24,000 for the entire bay region. These maps will make it possible to identify trends in wetland and seagrass losses and to determine what wetlands were changed to and the location of these changes. This task will provide valuable locational data for planning future mitigation sites.

Characteristics to be shown on the 1:24,000 biological and physical maps for the bay include the following:

1. Biological-shellfish harvest areas (approved); oyster beds (private and public); clam beds; finfish distribution (by habitat for spawning, nursery, and harvest); shorebird colonies; wading bird colonies; manatee habitat; seagrass beds; macroalgae beds; and artificial reefs.

2. Physical - salinity, point source discharges (municipal and industrial), dredged material disposal sites, tide stations, water quality stations, turbidity, conductivity, total chlorophyll, total nitrogen (from data 1978 to 1983), bathymetry, intertidal zones, sediments, tidal currents, and freswater-saltwater interfaces.

Additionally, a narrative accompanying the maps will include references for mapped data and textual information for the various characteristics portrayed. These maps should provide valuable data for planning future mitigation sites in the bay.

Geographic Information System

The FWS will digitize the maps it prepares using its Analytical Mapping System. All digitized data will then be entered into the FWS Map Overlay Statistical System for analysis. Analyses to be performed include identifying habitat trends or changes and evaluating mitigation sites. Examples of potential outputs include (1) the proximity of sites to manatee habitat or point source discharges; (2) modeling habitat suitability for selected species such as pink shrimp, brown pelican, and flounder; and (3) determining habitat changes (type and area) for future dredge disposal sites. Products from these analyses include computer-generated color maps, tables, and figures.

Estuarine Profile

The Estuarine Profile synthesize existing information on Tampa Bay. Ecological components, values, functions, and processes will be integrated from a comprehensive review of current research results and scientific literature. The Tampa Bay profile will be a concise and holistic treatment of the bay. Topics will include geological, physical, and chemical setting; habitats; biological components; ecosystem couples and linkages; impacts and management implications; and identification of information gaps.

Mitigation Options Document

The last task will be to develop a mitigation options document for Tampa Bay. It will analyze past mitigation actions and recommend a range of measures that may be included in future mitigation plans. This document will include a feasibility andlysis of the various mitigation options such as marsh creation and seagrass transplants. It will also identify specific sites for future mitigation and the type of mitigation feasible for each site. Lastly, the document will develop site-specific environmental management and restoration recommendations for the bay.

Outlook

These efforts will themselves provide valuable new information on Tampa Bay and on the potential impacts of future port projects. More important, however, they may eventually form the nucleus of a broader effort to establish a long-term strategy for dredged material management in the bay.

Concurrent with these efforts, the Port Authority is planning the development of a 25-year permit for maintenance dredging throughout the port. Such a permit will require a long-term plan for the use and management of existing and future enclosed maintenance dredging disposal areas, including two large disposal islands in the bay. The production of such a plan will require port interests and the Corps of Engineers to reach some agreement at least on the disposal of dredging material from future construction.

All involved hope that these future disposal plans will be linked to the mitigation options developed in this current effort to produce a broader dredging, disposal, and mitigation plan that is sensitive to economic, engineering, and environmental considerations.

Implementation of the findings of this study will be affected by four major factors: (1) the ability of federal agencies to enter into long-term agreements regarding mitigation efforts that are not part of a specific project, (2) the development of workable rules for long-term mitigation programs by State of Florida, (3) the ability and willingness of port interests to limit their long-term options, and (4) the development of mechanisms to finance long-term mitigation efforts before beginning specific projects.

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A COMPARISON OF THE ABUNDANCE AND DIVERSITY OF FISH AND SHRIMP IN BARNEGAT BAY AND A REPRESENTATIVE LAGOON SYSTEM IN NEW JERSEY

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New Jersey Department of Environmental Protection

Introduction

New Jersey's shoreline includes extensive man-made lagoon or canal systems created to provide waterfront residential lots. These lagoon systems were created by the dredging and filling of salt marshes and some forested wetlands prior to passage of the Wetlands Act in 1970 and subsequent promulgation of wetlands maps. Most of these lagoons were dredged 20-25 feet deep in order to obtain sufficient fill to construct houses on the wetlands, but most have a shallow shelf along each side.

In 1980, the State of New Jersey asserted its jurisdiction over development activities conducted in man-made lagoons, including dredging, bulkheading and filling. Prior to that time, these lagoons were regulated solely by the U.S. Army Corps of Engineers. In 1982, 267 permit applications were submitted to the N.J. Department of Environmental Protection for work in man-made lagoons; in 1983, the number of applications was 287, and in 1984 229 applications were submitted by October 1. About 40% of these applications proposed dredging or construction of a bulkhead and filling outshore of the mean high water line. Typically, the area to be filled or dredged consisted of shallow waters, less than 4 feet deep.

The New Jersey Coastal Zone Management Program includes rules which govern permit decisions. These rules, adopted in 1978, discourage filling in all water areas, except for minimum fill for water dependent uses where no alternatives are available.

The question soon arose as to the applicability of these rules to lagoons. Although the ecological importance of natural shallow estuarine waters has been well documented in the scientific literature

(Odum et al., 1974; Tatham et al., 1978; Tyrawski, 1979), the shallow and intertidal zones of man-made lagoon systems have not been extensively studied.

A study conducted by Rutgers University and the N.J. Department of Environmental Protection (Sugihara et al, 1979) compared physical, chemical and biological parameters of a tidal marsh system to a nearby lagoon system. The lagoon exhibited a strong summer thermocline and a lesser winter thermocline. The deep bottom waters in the center of lagoons were anoxic in summer and frequently had low oxygen levels the rest of the year. The oxygen depression and stratification were more intense further into the lagoon system. Net primary productivity was significantly lower in the lagoon system than the marsh system. Benthic sampling indicated lower numbers and biomass of benthic invertebrates in the lagoon than in the bay, with lesser amounts further into the lagoon. Species diversity was also lower in the lagoon. Fish were sampled using seines and trawls. Seine catches were not quantitative, but those fish species which were most abundant were caught at each station type (i.e., bay, creek and lagoon), although no comparison can be made as to relative abundance in each waterway. Trawl sampling was standardized and, during the winter, spring and summer samplings, few or no fish were caught in lagoons by trawl, while the creek and bay stations yielded fish all year.

Generally, studies have shown lagoons to have very low oxygen levels in deep waters and much lower primary and secondary productivity than the marshes from which they were created. Accordingly, creation of new lagoons is prohibited in New Jersey under the Wetlands Act of 1970 and New Jersey's Coastal Zone Management Program. However, numerous undeveloped lagoon lots exist in the State, requiring permit review and decisions. Based on the Rutgers/DEP study, the poor circulation and long length of lagoons, the fact that a productive and valuable system has already been destroyed in constructing a lagoon and personal observations, several options for regulating lagoon development were discussed among state and federal officials. These options were:

1. Permit filling and bulkheading to property lines in lagoons.

2. Permit filling and bulkheading on lagoon lots located more than 500 feet from a natural waterway.

3. Permit filling and bulkheading on lagoons already substantially bulkheaded.

4. Permit filling and bulkheading to the existing limit of fill in all lagoons.

In the summer of 1983, the Division of Coastal Resources established guidelines which require that bulkheads be placed along the mean high water line in lagoons, except on individual lots 75 feet or less in width which are located between two existing bulkheaded lots. In such cases, filling is allowed. Meanwhile, the Division, in cooperation with the Divisions of Fish, Game and Wildlife and Water Resources, undertook a sampling program to evaluate the habitat value of lagoon edges less than four feet deep. These areas are commonly the subject of permit applications. This paper addresses fisheries results. The Division of Water Resources aspect, only touched upon here, focused on water quality and the benthos.

Materials and Methods

A lagoon system off Barnegat Bay in Lacey Township, Ocean County, New Jersey was selected for the study. Two unbulkheaded bay stations and six lagoon stations were selected (Figure 1). The lagoon stations were chosen to compare (1) bulkheaded shorelines to unbulkheaded shorelines, (2) unbulkheaded shorelines at different distances from the bay, and (3) a lagoon less than 50% bulkheaded to one more than 80% bulkheaded.

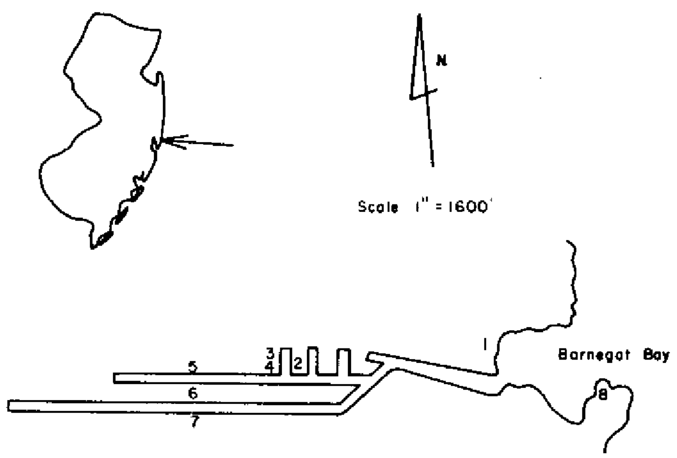

Figure 1: Site and station location map

Each station was seined biweekly for one year, beginning in March 1983, and using a 25 foot x 4 foot bag seine with a 0.25 inch mesh. Each station was sampled twice (morning/afternoon) on each date, and water temperature, salinity and oxygen concentration measured.

Each catch was counted by species and a total wet weight for each species determined. Samples which were too large to be counted in the field were preserved and sorted, counted and weighed later in the lab. The catches for the two replicates at each station have been averaged and converted to catch per 50 square meters. Data has not yet been statistically analyzed. Results for seven of the eight stations will be discussed. The eighth station, a bay station will not be discussed. On sampling days, there were often small waves at this station, water was shallower than the other stations, and catches lower and not comparable.

In addition to the fisheries sampling program, the Division of Water Resources gathered water quality (nutrients, oxygen and coliform), phytoplankton, benthic algae and benthic invertebrate data. The data will not be discussed here, except to indicate that 68 benthic invertebrate species were collected, with the bay dominated by filter feeders and all lagoon stations dominated by detritovores, particularly polychaetes and crustaceans.

Results and Discussion

Water chemistry

Temperatures ranged from 0 to 30°C during the study period. Salinity ranged from 14 to 22 ppt at 7 of the 8 stations until February and March of 1984, when it was only 6 to 12 ppt. One of the bay stations (Station 8) had generally higher salinities (19-24 ppt). Oxygen reached low levels of 5-6 mg/l in July, August and September at all stations, but generally ranged from 8 to 11 mg/l the rest of the year.

Species collected

The most abundant fish were mummichogs, rainwater killifish, tidewater silversides, sheepshead minnows, and bay anchovies. Both grass shrimp and sand shrimp were also common. These species are all important forage fish for many recreationally and commercially important finfish species.

Comparison of bay to lagoon and effect of distance from bay

Unbulkheaded bay (Station 1) and lagoon (Stations 4 and 5) stations were compared. The study indicated that lagoon Stations 4 and 5 were utilized as much as bay Station 1 most of the year in terms of biomass, with the catch at Station 5 frequently exceeding the catch at the bay station (Figure 2). The catch at the second lagoon station, Station 4, was more comparable to the bay. Station 5 is 4,200 feet from the bay; Station 4 is 3,000 from the bay. Note that distance from the bay did not result in a lower biomass in the shallow waters of the lagoon. It is possible that some fish escaped the seine at Station 4, due to the bank overhang. All other stations had either a beach or bulkhead along the shoreline, simplifying seining.

While the biomass caught in the bay at Station 1 exceeded that caught at Station 4 in late summer, this was much less apparent in terms of numbers caught, because shrimp were more abundant at the lagoon Stations 4 and 5 than at the bay station, particularly in the fall. Station 5 exceeded the bay in both number and biomass on all but two days.

Although the catches were generally higher at Station 5 than at the bay station, the number of species caught was greater in the bay during the summer and fall, and similar most of the winter and spring (Figure 3). Distance into the lagoon did not affect species composition.

Bulkheaded versus unbulkheaded lagoon shorelines

In order to compare bulkheaded shorelines to unbulkheaded shorelines, two sets of paired stations were selected, each pair consisting of a station with bulkheaded shoreline (Stations 3 and 6) and a station with unbulkheaded shoreline (Stations 2 and 5). These stations were located across the lagoon from one another. The data for one of these pairs (Stations 2 and 3) is shown here. For both pairs, higher biomass and greater numbers were collected at the unbulkheaded stations than at the bulkheaded stations most of the year (Figure 4). This relationship did not hold in the late winter/early spring. When data on number of individuals was broken down into fish and shrimp, this trend held true for fish only. The number of shrimp was similar at bulkheaded and unbulkheaded stations from late winter through summer. In addition to finding higher numbers and biomass along an unbulkheaded lagoon shoreline than a bulkheaded lagoon shoreline, more different species were found on a given day at the unbulkheaded station in the pairing of Stations 2 and 3 (Figure 5). This trend was not noticeable at the other paired stations (5 and 6).

The data indicate that the shallow waters along unbulkheaded lagoon shorelines support more fish and shrimp than those along bulkheaded shorelines. However, even the shallow waters in front of bulkheads are productive.

Developed nature of lagoons

In order to look at the effect of lagoon bulkheading on the remaining unbulkheaded shorelines, two unbulkheaded lagoon stations, each located 4,200 feet from the bay, were sampled. Station 5 was located along a 2,000 foot long stretch of unbulkheaded shoreline, on a lagoon less than half of which is bulkheaded. The other station, Station 7, was located on a lagoon more than 80% bulkheaded, and is a 75 foot wide lot with bulkheads on each side.

Results indicated that in the summer and fall the biomass was generally greater at Station 7 than Station 5 (Figure 6). Numbers were also higher at Station 7, with one exception due to a catch of several thousand grass shrimp. In addition, more species were collected at Station 7 than Station 5 (Figure 7).

This indicates that the bulkheading of most of a lagoon's shoreline does not negate the value of the remaining unbulkheaded lots on that lagoon. Indeed, perhaps it results in increased value to the shallow waters of the unbulkheaded lagoon edge.

Summary

As a result of this study, five generalizations can be made.

1. Lagoon shallows are utilized by both fish and shrimp, some areas supporting larger numbers and biomass than the nearby bay station and some supporting less.

2. Species diversity is greater in the bay than in the lagoon.

3. Increased distance from the bay does not result in decreased shrimp and fish utilization.

4. Shallow waters along unbulkheaded lagoon shorelines support more fish and shrimp, both numbers and biomass, and may have higher species diversity, than shallow waters along bulkheaded shorelines.

5. Shallow waters along unbulkheaded lagoon shorelines do not lose habitat value even when up to 80% of the lagoon is bulkheaded.

The study supports the Division's policy of discouraging filling of lagoon waters even when bulkheading is approved. Furthermore, the study indicates that shoreline stabilization by vegetation would be preferable to bulkhead stabilization from the point of view of preserving the value of the lagoon habitat. The preservation of lagoon shallows is all the more important as they may be the only significantly productive portions of lagoons.

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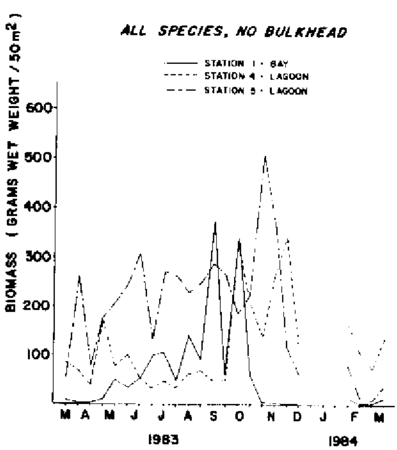

Figure 2. Seasonal variation in biomass at unbulkheaded bay and lagoon stations.

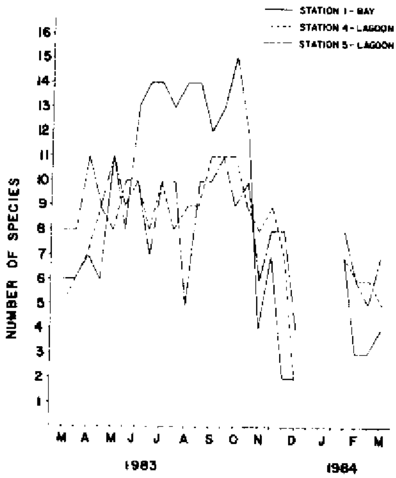

Figure 3. Seasonal variation in number of species at unbulkheaded bay and lagoon stations.

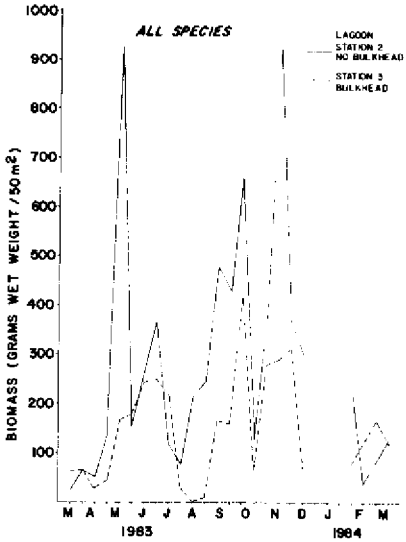

Figure 4. Seasonal variation in biomass at bulkheaded and unbulkheaded lagoon stations equidistant from Barnegat Bay.

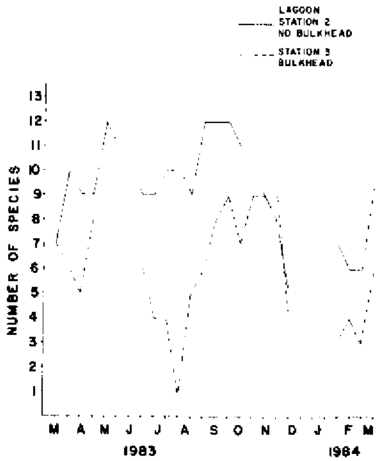

Figure 5. Seasonal variation in number of species at bulkheaded and unbulkheaded lagoon stations equidistant from Barnegat Bay.

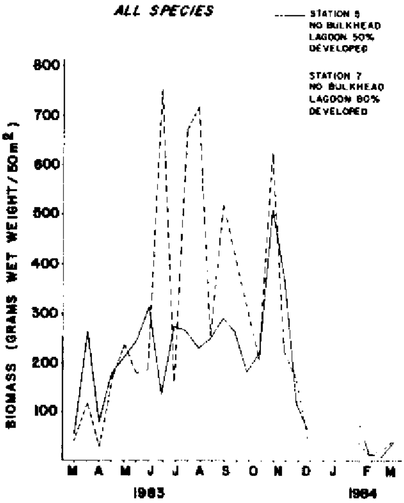

Figure 6. Seasonal variation in biomass at unbulkheaded stations on two lagoons equidistant from Barnegat Bay.

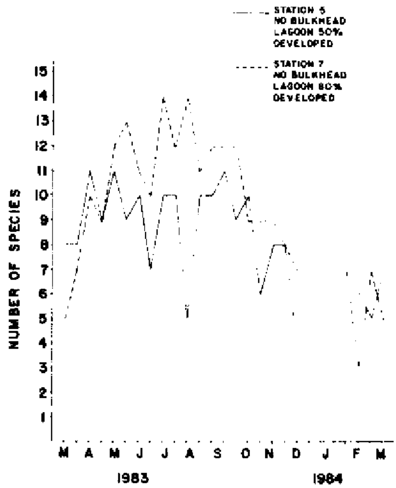

Figure 7. Seasonal variation in number of species at unbulkheaded stations on two lagoons equidistant from Barnegat Bay.

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USING SENTINEL ORGANISMS TO MONITOR CHEMICAL CHANGES IN THE COASTAL ZONE: PROGRESS OR PARALYSIS

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Introduction

Increasing pollution of coastal areas by xenobiotic chemicals such as synthetic organic compounds, petroleum, trace metals and radionuclides has led to the search for an effective monitoring program that has a capability to discern spatial and temporal trends in the environmental concentration of chemicals of concern. One strategy that has been tested in prototype monitoring programs is the use of bivalve filter-feeding molluscs as sentinel organisms. Because of their sedentary habits and their ability to bioconcentrate the pollutants of interest, mussels and other bivalve species appear to be appropriate sentinels for the detection of chemical changes that may be deleterious, over the long term, to the integrity of the coastal environment and to the health of man.

While no single approach is perfect, sentinel organisms have proven to be a good tool for monitoring chemical contamination. During the 1970's a few national and international programs were established to investigate the use of such organisms as indicators of pollution. Particularly important among these programs were those of the Organization of Economic Cooperation and Development and of the International Council for the Exploration of the Sea. During the past few years the United Nations Environment Programme Regional Seas Program has placed a major emphasis on the development of capabilities for measuring the levels of pollutants in coastal and marine environments. The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization has also recently sponsored the formation, from representatives of West Pacific region nations, of a task team to investigate marine pollution research and monitoring by using commercially exploited shellfish as indicator organisms.

National governments in many countries are initiating their own programs as a part of the effort made to provide longer-term protection of coastal zones from the deleterious effects of chemical contamination.

In the United States, the Mussel Watch Program was begun in the mid-1970's and built upon earlier regional and national programs. This program has used mussels (and oysters) as indicators of concentrations of several major classes of chemical pollutants in coastal waters; principally the higher molecular weight synthetic organic compounds, petroleum and its derivatives, other fossil fuel compounds, a number of trace elements, and the radioactive transuranic elements produced in the nuclear fuel cycle and weapons testing. Sample collections were made over a three-year period and the results of chemical analyses of this national collection have been reported. Additional work in several regions has continued since the original 3-year program and an improved perspective on the role of sentinel organisms in coastal monitoring has been gained. However, no further national collection has been made although such a program is currently under discussion within NOAA and EPA.

The results of these national and regional programs now permit a more comprehensive assessment of the sentinel organism concept and its application to other coastal areas. In November of 1983 an international workshop was held to discuss the detection and measurement of chemical changes in the coastal environment and to assess the concepts and methodologies used in obtaining monitoring data. Fifty-three representatives from twenty-eight countries met and the results of their discussion are now being edited for publication. We present here a brief summary of our interpretation of some of the major points generated from discussions at this workshop. We will not present Mussel Watch data here as it is available in technical reports and journal articles published elsewhere (see References).

The Need for Monitoring Coastal Contamination

Several areas of the U.S. coast have been found to contain chemical contaminants in sufficient concentrations to cause concern for the health of human consumers of seafood and this situation is the same in many other countries. Chemical contamination of this magnitude also raises questions concerning the viability of populations of commercially valuable organisms. In spite of efforts to improve husbandry, industrialized society continues to lose chemicals to the environment via point source and non-point source release. This continuing input of contaminants requires a continuing assessment of chemical concentrations in coastal areas.

Random measurements of specific chemical contaminants in arbitrarily selected field samples do not address issues such as natural variability and results may be actively misleading. In order to produce an unbiased estimate of variation in the natural system, a monitoring program needs to be designed to address specific questions. The questions must be asked first and then data gathered to answer them; randomly accumulated data cannot often be applied to answer questions asked after the fact.

Is the reduced use of specific chemicals of environmental concern (e.g. lead, DDT) reflected in a corresponding reduction in environmental concentration? What will be the consequences of increasing ocean dumping activities or of shifting ocean dumping to deeper water? Specific questions such as these can be addressed by a monitoring program that is designed to meet specific objectives. We can formulate a series of objectives:

1. protection of human health, i.e. tracing the route back to man
2. protection of commercially valuable living natural resources
3. protection of special groups of organisms such as marine mammals or birds
4. protection of the ecosystem that supports biotic diversity.

These objectives can be met in a variety of ways but increasingly complex information is required as we proceed through this list. For example, the analysis of market samples would be a straightforward and relatively inexpensive way to provide a substantial protection for human health. Objectives 2 and 3 can be met in part by monitoring only species of concern and this again could be done quite easily. However, if we wish to obtain information concerning sources of contaminants, concentration trends in space and time and a regional assessment of contamination then a different approach is needed. This approach includes research into the processes that affect the input, transport pathways and ultimate fate of contaminant chemicals in the coastal environment.

Although analyses of sediment and water samples can legitimately be part of a monitoring program, we emphasize the use of sentinel organisms here primarily because of bioavailability. The issue of bioavailability is an important one because sediment-bound contaminants are not necessarily as available to uptake by organisms as they are to chemical extraction.

Several workers have discussed the ideal attributes of a good sentinel organism and these are listed here:

- The organism should be cosmopolitan in order to minimize problems inherent in comparing data from the analysis of different species with varying life histories and relationship to their habitat.

- A simple correlation should exist between the pollutant content of the organism and the average pollutant concentration in the surrounding water.

- The organism should accumulate the pollutant without being killed by the levels encountered in the environment.

- The organism should be sedentary in order to be representative of the study area, although territorial species may be chosen if information on a regional scale is sought.

- The organism should be abundant throughout the study area and be found in stable populations that can be sampled repeatedly.

- The organism should be sufficiently long-lived to allow the sampling of more than one year-class if desired.

- The organism should be of reasonable size, giving adequate tissue for analysis.

- The organism should be easy to sample and hardy enough to survive in the laboratory, allowing defecation before analysis (if desired) and laboratory or transplant studies of pollutant uptake.

- The organism should tolerate a wide salinity range.

- The organism should have minimal (or well understood) enzyme systems that metabolize the contaminants in question so that an assessment of the magnitude of contamination in the environment can be made.

- Organisms that are of commercial value or can be cultured are of immediate interest and work with them will have immediate economic value.

- Background data on such parameters as kinetics of uptake and release, taxonomy, sexual cycle, lipid chemistry, growth rates, etc., should be known or obtained early in a monitoring program.

Sentinel organisms can be selected to address specific questions and it should not be inferred that bivalves are the only appropriate monitoring organism. Although migratory, territorial species might be used to serve as monitors of regional areas: e.g. finned fish and birds may bioaccumulate certain contaminants at very high concentrations thus making analysis easier. When including organisms other than bivalves, rates of bioaccumulation and metabolism must be assessed prior to interpretation of monitoring results. In some cases metabolism of contaminants can be a positive factor in that it permits study of the more recalcitrant chemicals.

Strategies for Monitoring

Measurements of contaminant levels in even a well chosen sentinel organism are not very meaningful unless they are made within the context of the processes that affect their input, transport, degradation and storage. Taking a holistic approach, analysis of contaminants needs to be done simultaneously with physical and chemical measurements of water, water movement and sediment transport processes. These factors need to be integrated with the biological factors. However, resources available to any monitoring program are finite, therefore, the compounds to be assessed and the method of assessment must be chosen with care. In order to make efficient use of available monitoring resources we need to continually phrase associated research questions so that the results can be applied generically to the greatest extent possible and are not inherently constrained by site specificity.

An order of priority in establishing the methodology and sequence of measurements when extending monitoring programs into new or unknown areas should be considered. The following general guidelines are suggested to achieve a cost effective multistage approach:

- site selection should be based on a preliminary assessment of all relevant background information, supplemented if necessary by a preliminary survey of sentinel organisms.

- establishment of a longer term monitoring program in coastal sites selected to identify hot spots of contamination and unpolluted reference sites.

- determine temporal and spatial trends from a more comprehensive study of selected sites.

- create a heirarchical analytical scheme to identify specific samples for high resolution analysis following identification by simpler scanning techniques.

- investigate biological impact and long term accumulation of toxicants in local ecosystems.

Developing Countries and International Cooperation

Monitoring of chemical contamination in developing countries involves the same principles and the lessons already learned by industrialized countries can be applied to new areas. Background information may not be as available as it is in the more industrialized countries, therefore, acquisition of basic background information might necessarily be a larger component of monitoring programs in some situations. Other requirements such as trained personnel and sophisticated instrumentation may not be easily available in developing countries and a realistic assessment of available resources should be incorporated into the design of these monitoring programs. It will not be possible to institute state-of-the-art monitoring in many places but joint efforts with the more developed countries will permit a significant effort to be made. Recent efforts by UNEP and IOC-UNESCO indicate the need for training and for assistance with modern chemical and biological techniques. Training programs are making substantial progress in some regions and further joint efforts with laboratories in developed countries can only increase this progress. We suggest that laboratories currently using high resolution analytical techniques participate in in-country training programs and analyst exchange programs as a way to increase analytical expertise around the world. Intercomparison/intercalibration exercises should continue to improve reliability of data and the search for reliable, simpler, less expensive analytical techniques should continue while present techniques are applied to monitoring needs.

Research

Basic research into fundamental processes continues to be important because understanding of the functioning natural systems affected by chemical contamination remains imperfect and will remain so for the foreseeable future. We have learned much in the recent past and have begun to place such processes as input, fate and effects into perspective. However, quantitative information on these processes is still being produced and while major questions remain unresolved any monitoring effort must be able to respond to new developments as they occur. As our understanding becomes more sophisticated we will need to ask different questions (or ask the same questions differently) and a monitoring program should not be so rigidly designed that it cannot be adapted to the new information. Knowledge is not adequate at present to establish several aspects of desired monitoring programs and a major part of a monitoring effort should be a continued attempt to understand the natural processes that make up the system being studied.

Monitoring Programs: The U.S. Experience with Mussel Watch

The bivalve sentinel organism concept can be used in the assessment of the current status of coastal contamination and the estimation of spatial and temporal trends. We believe that the U.S. Mussel Watch experience has shown the validity of the sentinel organism concept and that valuable environmental data can be obtained from a monitoring program that incorporates bivalves as a component. Confusion about the goals of the initial U.S. Mussel Watch program is perhaps one factor that is impeding the establishment of an operational monitoring program at this time. The greatest challenge in a monitoring effort is the definition of the objectives. The monitoring effort must be designed to answer specific questions and these objectives must be widely understood from the start. The objectives of the U.S. Mussel Watch program were to assess the current status (1976-78) of contamination by a selected group of chemicals in waters of the U.S. outer coast. The focus was on 1) the detection of regional trends, 2) the identification of "hot spots" of elevated concentrations, 3) the accumulation of a valid data set for one time period that could be used to assess long-term trends, and 4) the determination of monthly, seasonal, and annual variability of pollutant chemical concentrations in organisms. Data obtained from the U.S. Mussel Watch program have been successfully applied to the original objectives of the program and the experience provides the foundation for new monitoring efforts. The major deficiency we have identified in the data is that sampling intensity was insufficient to detect many local "hot spots". This deficiency reflects a lack of sufficient funds, not an error in planning or strategy.

The U.S. Mussel Watch program contained a substantial research effort that addressed specific questions as they arose but an operational program might not contain that level of research effort. In addition to a clear definition of goals, the creation of an operational monitoring program that can adequately assess the chemical contamination of coastal waters will require continuing research at some level. Once goals are established, scientific and technical capabilities will probably need to be developed to meet some of the goals. Our knowledge of the natural system is not complete and the results of research will have to be continually incorporated into existing monitoring efforts if the monitoring data is to remain credible.

While design of an operational program is possible, non-scientific impediments exist that block implementation. Interagency rivalries and conflicting or undefined jurisdictions are a frustrating reality. The continuing re-examination of monitoring goals is an ongoing activity that seems to delay action. Issues such as these are being addressed but real progress at times seems sluggish. The paralysis of inaction risks the loss of valuable data and we urge a vigorous effort to resolve the existing problems. The recently established program of National Status and Trends in NOAA's Ocean Assessment Division is a step toward a national monitoring program. This program seeks to "assess and document the status and long-term changes of environmental quality of the nations' coastal and estuarine environments." A request for proposals, issued in July, 1984 and quickly withdrawn, is but one example of the erratic progress being made toward the creation of a national coastal environmental quality monitoring program. We suspect that the primary impediments to the establishment of a monitoring program are not simply related to lack of scientific and technical information. Rather, problems in the definition of the goals of such a program and relating these goals to a vaguely defined national policy are probably paramount.

Conclusion

Given that contamination by chemicals in coastal areas can have an adverse effect on human health and on natural resource populations, it would be desirable to be able to predict such effects and to govern our waste disposal practices accordingly. Ideally, we would like to have data on the concentrations of pollutants in all segments of the ecosystem, pathways and rates of transfer of pollutants between these segments and the adverse effects of these pollutants from the subcellular to the ecosystem level. This holistic approach will continue to be the ultimate goal of scientific research in coastal environmental quality.

The complexity of nature is a reality and will inherently introduce some uncertainty into monitoring data. This is not an acceptable excuse for the paralysis of inaction in establishing a monitoring program for chemical contamination in coastal areas. Part of the success of previous efforts has been the recognition that such complexity exists and that monitoring programs must be designed and operated within that context. Uncertainties are inherent in scientific and technical knowledge and our decision making process needs to incorporate these uncertainties. Decisions that have environmental, economic and social impacts will be made and we cannot permit the uncertainty caused by the complexity of natural systems to paralyze research, environmental assessment and resource management in coastal areas. A monitoring program is important, not only to warn us of an existing or impending problem but also to inform us that a chosen practice is functioning as predicted.

An operational monitoring program to monitor chemical contamination in coastal areas can be implemented now and the concept of sentinel organisms can be an effective component of a monitoring program.

Acknowledgements

The ideas expressed here are a distillation of many productive discussions with colleagues of the U.S. EPA Mussel Watch program and the SCOPE workshop, Chemical Changes in the Coastal Zone: Mussel Watch II, held in November 1983 in Honolulu, Hawaii. Financial support from Andrew W. Mellon Foundation and International Federation of Institutes for Advanced Study grants to the Coastal Research Center of the Woods Hole Oceanographic Institution and from U.S. Environmental Protection Agency Contract No. RO 3004-68-03-3193 are gratefully acknowledged.

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VARIATIONS IN SEDIMENT BUDGET AND MORPHOLOGY AT OREGON INLET, NORTH CAROLINA

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Many scientists as well as the National Park Service are on record as being opposed to the Oregon Inlet jetty project as proposed by the Corps of Engineers. The project would disrupt the ecology of the area. Land in the Cape Hatteras National Seashore has recently been approved for construction purposes by Congress. Because this project is extremely controversial, it seems appropriate to study the ramifications surrounding the project as much as possible, before funding becomes available.

The research here attempts to define the nature and magnitude of geomorphic change in the vicinity of Oregon Inlet. Rates of morphometric change and sediment budgets are presented as base line data as they are related to the dynamic stability of the inlet and the adjacent coastline.

Historical Changes

Oregon inlet is part of the barrier island system separating Bodie Island to the north and Pea Island to the south. The inlet is important for navigation since it is the only inlet at the present time between Cape Henry and Hatteras Inlet. State and local officials view the stabilization of the inlet essential to the economy of the area, especially for the local fishing industry at Wanchese Harbor on Roanoke Island.

Early charts of the study area show several inlets in the vicinity of Oregon Inlet (Figure 1). Because of the inaccuracies of these early charts it is difficult to determine which might be the predecessor of the present inlet. The existing inlet opened during the hurricane of September sixth and seventh in 1846. An 1843 chart shows an inlet in the area, but some distance south of the present location. The closing of Roanoke Inlet, the one Sir Walter Raleigh supposedly used in 1584, prompted politicians of the period to promise to reopen the inlet if elected.

The inlet was relatively undisturbed except for occassional dredging until 1964 when Bonner Bridge was completed. While it has been hypothesized that the bridging has contributed to inlet migration, narrowing, and shoaling, it has not been substantiated. More than likely, it has been the decrease in storm fequency and magnitude since the hurricanes of the 1950's and the Ash Wednesday storm of 1962.

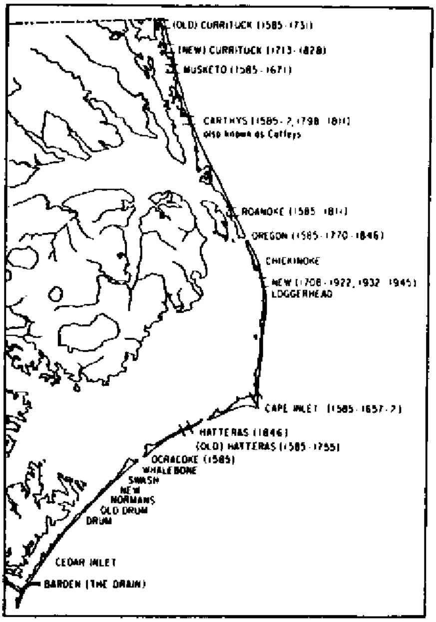

Figure 1. Inlet locations of the Outer Banks of North Carolina. Source: Birkemeier, 1981.

Data Sources and Analyses

For this investigation, the shoreline in the vicinity of Oregon Inlet is divided into three sections, which are: (1) the updrift ocean beach on southern Bodie Island, (2) the downdrift ocean beach on northern Pea Island, and (3) Oregon Inlet. The Oregon Inlet section can be further subdivided into three components, which are: (1) the sea shoals or ebb tidal delta, (2) the sound shoals or flood tidal delta, and (3) the inlet gorge or channel. An inspection of historic maps and charts between 1848 and 1982 shows that the inlet has been migrating southward at a rate of ninety feet per year (Figure 2). Concomitant with this southerly migration, is the change in inlet throat width (Figure 3). The width of the inlet throat in 1848, 1915, and 1949 ranged between four tenths and one half of a mile (Figure 4). The occurance of the Ash Wednesday storm resulted in a widening of the inlet to 1.6 miles (Figure 5). In 1982, calculations showed that the inlet throat had been narrowing since 1974 at a rate of three hundred and fifty-six feet per year in order to attain its present width of about three tenths of a mile. Since the opening of the inlet in 1846, considerable change has occurred with respect to the approximate location of the existing inlet and the proposed jetties (Figure 6).

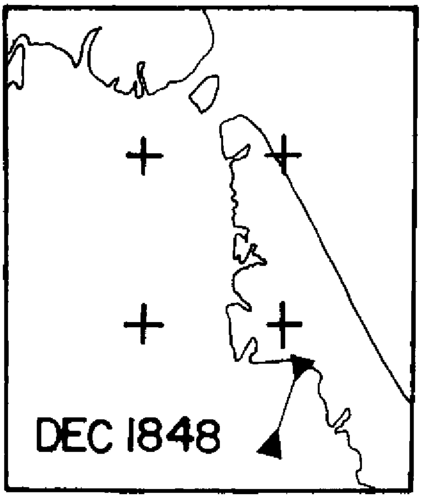

Figure 2. Inlet in 1848 with present gorge shown between triangles. (After Duke University Geol. Lab.).

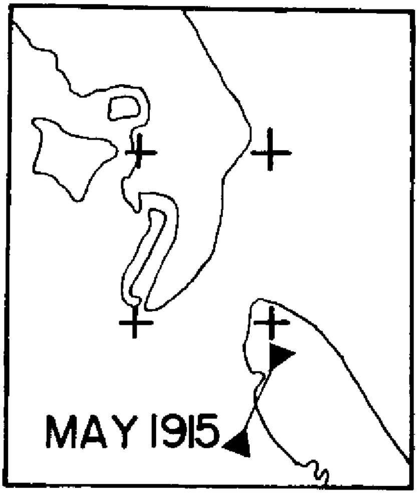

Figure 3. Inlet in 1915 with present gorge shown between triangles. (After Duke University Geol. Lab.).

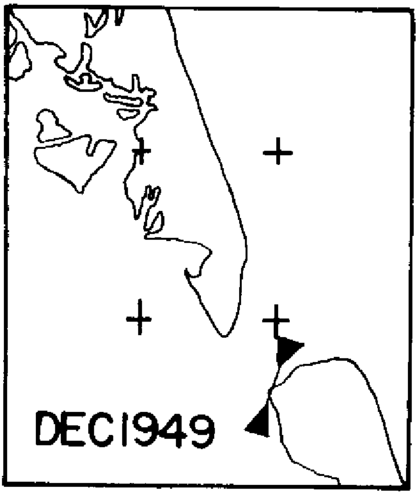

Figure 4. Inlet in 1949 with present gorge shown between triangles. (After Duke University Geol. Lab.).

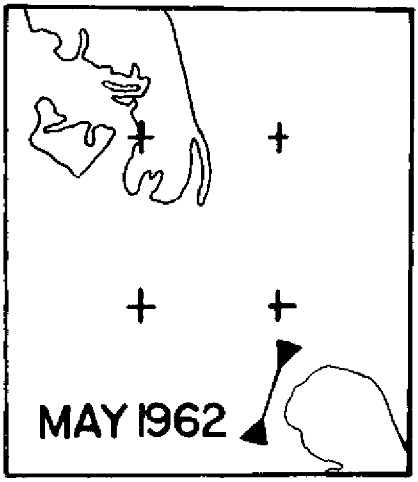

Figure 5. Inlet in 1962 with present gorge shown between triangles. (After Duke University Geol. Lab.).

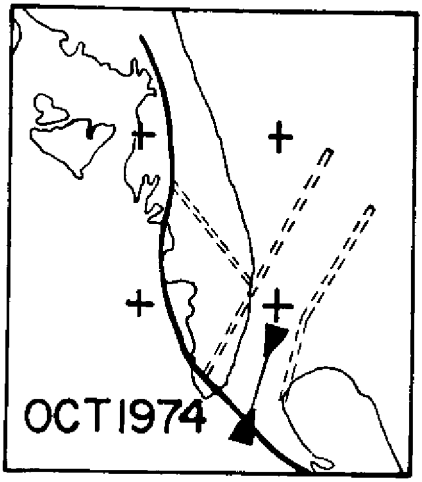

Figure 6. Inlet in 1974 with the location of the present gorge, the proposed jetty system and the Bonner Bridge. (After Duke University Geol. Lab.).

The main channel of the inlet has also been migrating southward through time and it has also tended to become shallower since the mid 1960's (Figure 7). Between 1937 and 1957, the depth of the main channel changed from twenty feet to thirty-two feet respectively. And

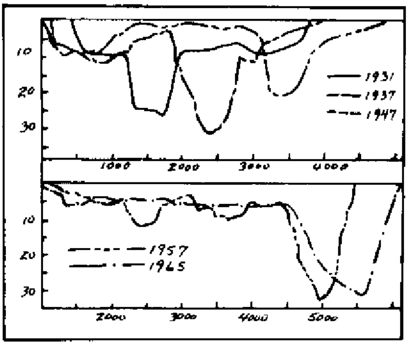

Figure 7. Inlet crossections. Source: Dolan and Glassen, 1973.

when the inlet attained its greatest cross-sectional area in 1965, the main channel of the inlet was thirty-one feet deep. The seemingly greater depth and cross-sectional area recorded in 1957 and in 1965 are thought to be related to the large number of hurricanes that occurred in the area from 1954 through 1959, and the impact of the Ash Wednesday storm of 1962. In the late 1970's, the bridge pilings near Pea Island were being undermined by the main channel and forced the bridge to be closed temporarily. The channel now must be dredged almost continually to maintain a depth and location required for navigation purposes.

The period between the Ash Wednesday storm and the present has seen relatively little storm activity. There has been a marked decrease in the frequency and magnitude of severe northeasters and a major hurricane has not made landfall within the locality of the inlet during this period. This quiescent period has been marked by a high accretion rate in both the ebb tidal and flood tidal deltas. Changes in the morphometry of the sound and the sea shoals were made by recording depth measurements along a series of transects. It was found that the mean depth of the ebb delta decreased from 17.6 feet in 1961 to 13.7 feet in 1972 (Figure 8).

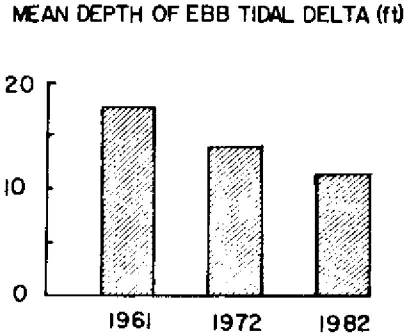

Figure 8. Mean depth of ebb tidal delta, in feet, for 1961, 1972 and 1982.

While between 1972 and 1982 the mean depth of the ebb delta decreased an additional two feet, to 11.7 feet. This rate of sediment accumulation represents an annual increase of 0.85 cubic yards of sediment per square yard of area or 805,513 total cubic yards per year over the area of the ebb tidal delta (Figure 9). The flood delta has

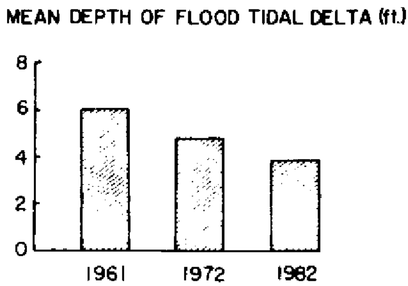

Figure 9. Mean depth of flood tidal delta, in feet, for 1961, 1972 and 1982.

also been decreasing in depth. Between 1961 and 1972, the mean depth of the flood delta decreased from six feet to 4.8 feet. While between 1972 and 1982, the mean depth decreased an additonal foot to a depth of 3.8 feet. This rate of sediment accumulation marks an annual increase of 0.31 cubic yards of sediment per square yard of area or 613,098 total cubic yards per year over the flood tidal delta. The total accretion for both the ebb and flood tidal deltas is calculated to be 1,418,611 cubic yards per year.

This accumulation of sediment in the inlet can be observed in the total area of the shoals exposed at low water in both the ebb and flood tidal deltas (Figure 10). Between 1961 and 1972, exposed shoals were not observed in the ebb delta. While in 1982, ten acres of shoals were exposed. Twenty-four acres of shoals were exposed at low water on the flood delta in 1961. This increased to fifty-five acres in 1972, and to seventy-nine acres in 1982. However, it must be realized that some of this accumulation could be spoil from dredging activity.

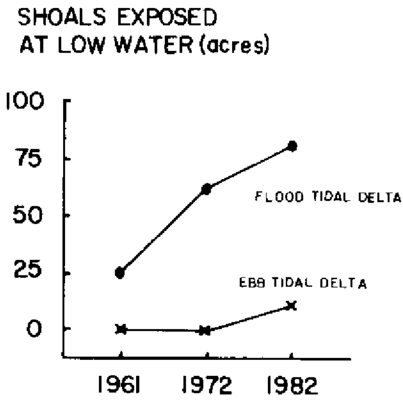

Figure 10. Acres of shoals exposed at low water for 1961, 1972 and 1982.

An examination was made of the updrift and downdrift ocean beaches at Bodie Island and Pea Island respectively in order to determine if any significant differences exist in the beach/dune complexes (Figure 11). Data for the analyses were derived from two engineering surveys dating from 1937 and 1976. A four mile reach of beach was examined on either side of the inlet. Within each section, twenty profiles were used. The profiles are located approximately one thousand feet apart and originate behind a foredune ridge baseline and extend to mean high water. Both the updrift and downdrift beaches were found to be receding with a rising sea level. The maximum amount of recession was found to be twenty-five feet per year, and occurred on the updrift section near Coquina Beach. The maximum rate of recession on the downdrift beach was twenty feet per year and occurred in the proximity of the National Wildlife Service Headquarters building on Pea Island. Additionally, an increase in dune height in excess of ten feet has been observed since 1937. This is the result of the construction and maintenance of a barrier dune line by the National Park Service.

Volumetric changes were calculated for the updrift and downdrift beaches (Figure 12). It was found that the updrift beaches were eroding at a rate of 114,000 cubic yards annually, while the downdrift beaches were accreting at a rate of 124,000 cubic yards annually. These figures represent a net loss of 5.39 cubic yards of sediment per linear foot of beach per year for the updrift beaches and a net gain of 5.87 cubic yards per linear foot per year for the downdrift beaches. These changes in the storage characteristics of the beach/dune complex represents a variety of coastal processes which relate to changes in beaches, capes and inlets.

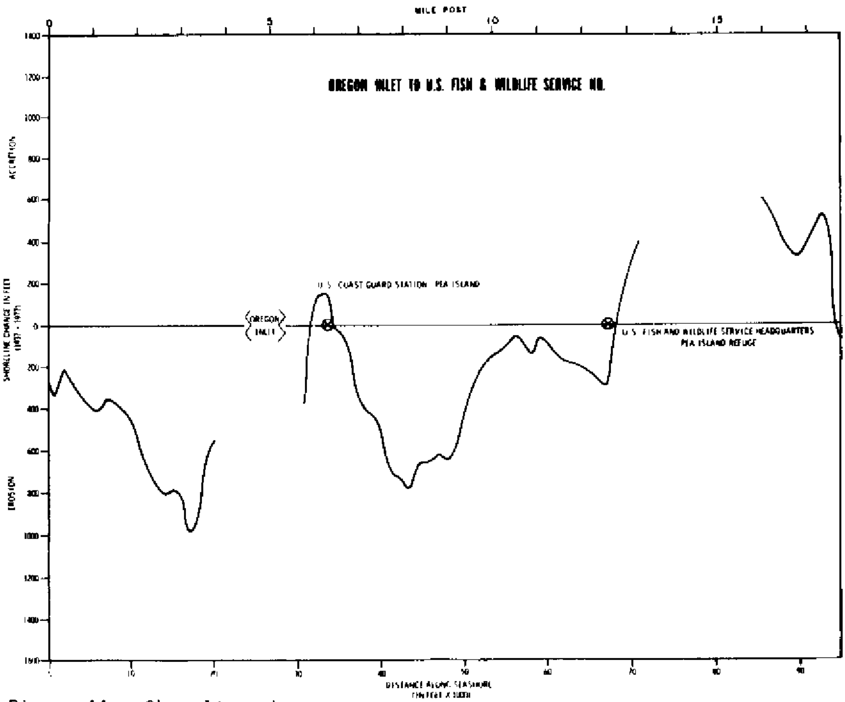

Figure 11. Shoreline change in the vicinity of Oregon Inlet. Source: Sharica, 1978.

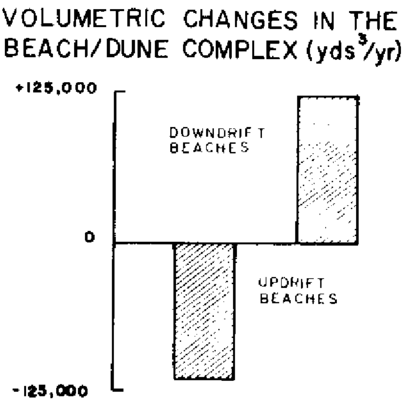

Figure 12. Volumetric changes in the beach/dune complex, in cubic yards per year.

Using data between 1972 and 1978 from the Corps pier at Duck, North Carolina (Figure 13), the average monthly and annual predicted rates of longshore transport can be determined based on the method recommended in the Shore Protection Manual (CERC, 1973). Along the northern portion of the Outer Banks the net longshore transport is to the south at a rate of 1,068,004 cubic yards per year. The sediment that is transported onshore is a significant factor in the present infilling at Oregon Inlet. But a total of 114,000 cubic yards of the longshore transport is derived from the updrift beaches within four miles of the inlet. Of the total 1,418,611 cubic yards that is deposited annually in the ebb and flood tidal deltas, 1,182,004 cubic yards or about 83.3 percent is derived from longshore transport. The remaining 236,607 cubic yards of sediment is derived from either sound or offshore sources. An exact determination cannot be made on the amount of sediment that escapes the inlet's sink annually because the downdrift longshore transport rate is not known. However, it is estimented that 124,000 cubic yards are being deposited annually on the four mile section of the downdrift beach on Pea Island. This amount is essentially equivalent to the amount being removed from the updrift beaches on Bodie Island.

Conclusions

Most barrier island inlets are in a state of dynamic stability and tend to close with time. An inlet's demise can be related to the movement of sediment and all that this implies, including the closing of other inlets that are less favorably located. At Oregon Inlet with its migration shoaling and narrowing, wave action is decreasing as is the tidal prism which tends to lessen the integrated flux of energy. This situation does not allow a significant amount of sand to move. For an inlet to remain open for a long period of time it requires the maximization of the tidal prism as compared to the littoral drift. The larger and more irregular the drift and the smaller the tidal flow the greater the possibility of the inlet shoaling and closing. Also, inlet efficiency is equal to the inverse relationship between the inlet's cross-sectional area and the sound area. In the case of Oregon Inlet the cross-sectional area has decreased since 1962 while we assume the sound area has remained the same. In 1965, while the cross-sectional area was larger than in 1937, the 1977 cross-sectional area was considerably less than in 1937 or 1965. It is suggested here that the 1962 Ash Wednesday storm scoured the inlet, but since that time, decreasing storm magnitude and frequency has allowed the inlet to become smaller.

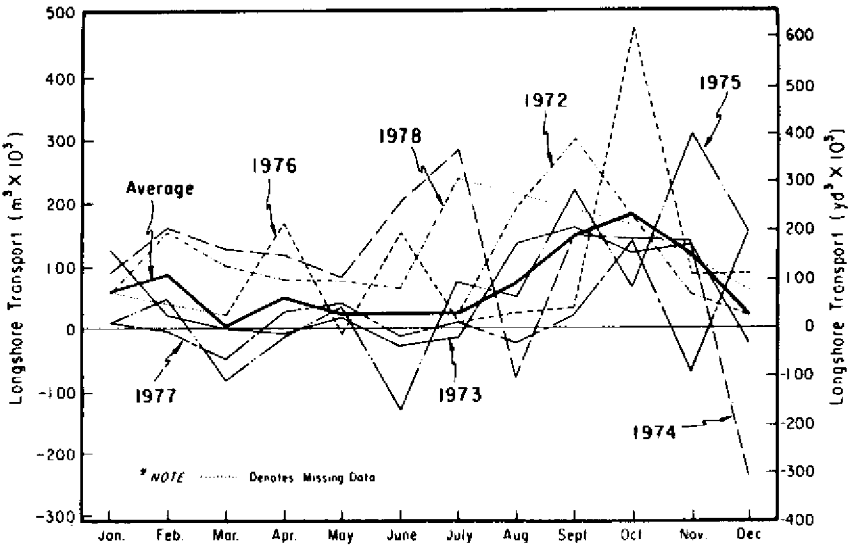

Figure 13. Longshore Transport at Duck, N.C. by month from 1972 to 1978. Source: Birkemeier, 1981.

The inlet's morphology, which consists of the sea and sound shoals and the inlet gorge, seemingly has changed with the cyclic nature of storms. The inlet's morphology also responds to changes in the longshore drift and the tidal prism. When drift is minimized and the prism is maximized there is commonly more than a single dominant channel through the inlet. Oregon Inlet, now has a single channel through the sea shoal which is dredged to maintain its location and a navigatable depth.

Any attempt to simplify the complexity of the inlet processes by jettying or even dredging, is tantamount to altering the tilt of the earth's axis, and expecting nothing to happen. It is strongly suggested here that more research is needed to decide on a long term management policy such as jettying; and that the short term dredging should be continued until jettying or hopefully other management alternatives are more intensively studied.

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MISCONCEIVED CAUSES OF CLIFF AND BEACH EROSION IN ROSSLARE BAY, SOUTHEAST IRELAND : A CAUTIONARY TALE FOR COASTAL ENGINEERS AND SHORELINE MANAGERS

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Introduction

Geomorphologists should be wary of making hasty judgements on coast erosion problems, especially as many of their views are accepted with alacrity by coastal residents and managers. This cautionary study describes how a major misconception as to the origin of a severe coast erosion problem in southeast Ireland has spawned a series of ill-founded protection measures. In a country where the total annual central government appropriation for coast protection schemes is less than $200000 such lack of under standing is a serious matter.

Study Area

Rosslare Bay is in the extreme southeast corner of Ireland (Fig. 1). While the east-facing bay is within the semi-enclosed Irish Sea, the shoreline plan owes more to control exercised by northerly moving Atlantic swell, refracted around the prominent headland at Greenore Point and as such Rosslare Bay appears to be a good example of a crenellate bay (Silvester 1970) moving towards some form of equilibrium between plan form and wave action as recognised world wide by the concept of log-spiral bays. Rosslare beach extends for 15 km, from Greenore Point to the estuary mouth spit at the entrance of Wexford Harbour. The 2-3 km of southern coast of the bay comprises low beaches and eroding glacial till cliffs up to 10 m in height. Near Rosslare village the cliffs give way laterally to spit sediments with a single low sand dune ridge, fronted by, at low tide, a 20-50 m wide beach. A shore-parallel bar occupies the inner nearshore zone. The shoreline terminates in a narrow sand spit, stretching out on the southern side of Wexford Harbour, a 50 km^2 estuary, partly maintained by discharge (10-350 cumecs) from the River Slaney.

On the north side of Wexford

Harbour is a southerly directed spit (Raven Spit) supplied with sediment from the rapidly eroding fluvio-glacial sand/gravel cliffs along the north County Wexford coast. Johnston (1984) advocates that the southerly longshore drift potential in the vicinity of the Raven Spit is four to five times that of the northerly longshore drift potential along Rosslare Bay. The intersection of the two drift systems is unclear - yet the presence of a substantial ebb-tide delta at the estuary mouth suggests that spit dynamics must be related to longshore sediment supply and tidal hydraulic interactions.

The spring tidal range is 1.6 m in Rosslare bay and 1.5 m in Wexford Harbour (estuary). Median wave heights are < 1m from all onshore directions, with southeast storm waves being the highest (Orford et al 1983).

History of Shoreline Erosion and Protection

The entire coast of Rosslare Bay is suffering from erosion. Figure 2 provides a summary of the available data based on map and airphoto analysis. The local view of this erosion, based on the perception of a residents action group at Rosslare Strand, is that it was initiated by the construction of a railway-ferry jetty (Ireland to Wales) north of Greenore Point in the 1880s at the position now identified as Rosslare Harbour. It is thought that the jetty impeded the northerly movement of longshore drift, so starving the beaches in Rosslare Bay and in the process threatening the centre of County Wexford's coastal tourism trade at Rosslare Strand. Almost all shore protection initiatives have been based on this impeded drift premise, notwithstanding the general lack of evidence.

In 1924-25 the distal 1200 m stretch of Rosslare Spit were breached by severe southeasterly storm washover thus isolating the coastguard station at Rosslare Fort (Fig. 3). The spit was finally beheaded in the late 1920s and over the next 50 years the spit terminus retreated about 2.5 km to its present position. This initial beheading seems to have precipitated a long-running battle over coastal erosion between the local residents, the local council (Wexford County Council), the national Government (the Board of Works) and the railway company (Corais Impair Eirann) who still maintain a rail link from Dublin to Rosslare Harbour. A number of piecemeal compromise coastal defence solutions have been undertaken since the 1930s, including the construction of timber and concrete bulkheads, timber groynes, timber palisades and slatted snow fences and rock armouring. Many of these solutions have been imposed over short stretches of shoreline by individuals wishing to protect their own property most notably by private hotels and by a golf course on the Spit. In places landfill and old cars have been dumped over the cliff to serve as protection. Between 1964-72 attempts to nourish Rosslare Strand with sediment from the deposits impeded updrift of Rosslare Harbour, helped to slow erosion at Rosslare, but disputes over sources of new sediment and legal action cut the amount of nourishment to negligible levels between 1971 and 1982. In 1983 the railway company CIE had to provide 105 x 10^3 m^3 of offshore dredge spoil in order to fulfil a requirement for beach nourishment. The sediment was placed on the beach at Rosslare Strand, but unfortunately, its fine size meant that it was rapidly removed offshore giving no lasting protection to the beach.

Further sources of sediment for nourishment have yet to be identified, but impeded drift reserves south of Rosslare Harbour are now virtually exhausted with little further accretion taking place at a rate sufficient to replenish the amount being used for nourishment between 1964-71.

The major coastal problem for Ireland in general and Rosslare, specifically, is that there has never been sufficient legislation or finance to allow a unified coastal management plan to be developed by which recognition of geomorphic processes and results could underwrite a coherent and acceptable coastal defence policy.

Geomorphological Assessment

Comparison of early maps (British Admiralty Hydrographic Charts - see Fig. 4) suggests that the pre-jetty erosion was at least of the same order, if not greater in some places (Fig. 2), than post-jetty erosion (Ordnance Survey 1:10560). Most of the coast is still eroding at between 0.6 m and 2.0 m per year though the rates are slowing down due to the combined impact of coastal protection measures. The till cliffs show an irregular spatial retreat pattern, comprising shallow rotational slides, spalling and localised mudslides and slumps. Most (> 75%) of the cliff material is of silt or clay sized particles, which appear to be transported seawards in suspension. Very little cliff debris remains on the beach. Some sand sized material moves alongshore to the north, but the volume is only in the order of 10^2–10^3 m^3 per year (Johnston, 1984) and is insufficient to provide beach protection. Most of this sand probably moves alongshore in the nearshore bar system outside the groyne field. Downdrift of the resort of Rosslare Strand, the dunes are trimmed frequently by high tides, and show no signs of any recent foredune accumulation. For most of its length the dune is only one ridge wide and is close to collapse by undermining in numerous places

While construction of the Rosslare Harbour jetty did result in accretion of a small shadow foreland, its openwork character (1880-1978) is exceedingly unlikely to have caused major disruption to any original dominant longshore sediment transport. On the basis of extracted sediment for beach nourishment purposes, the average pre-jetty drift rate past Rosslare Harbour was 5 x $10^3/m^3/yr$. This is commensurate with the current rate of sediment now being eroded in Rosslare Bay and entering the beach (c. 6 x $10^3/m^3/yr$. This suggests that the building of the harbour has not materially affected the northerly longshore supply to Rosslare Spit. The recent rebuilding of the Harbour (1978) with a replacement impermeable sea wall may, however, auger further longshore supply depletion. Inspection of map and field evidence casts considerable doubt on the importance of the coast east of Rosslare as a past major sediment source for supplying long term beach volumes that would have protected Rosslare Strand and more importantly built Rosslare Spit. Map analysis shows no long term shoreline changes, while the cliffs have well-vegetated, stable profiles at angles 10°–20° lower than the eroding cliffs within Rosslare Bay. We would argue that the development of a crenellate bay at Rosslare, west of the present Harbour position, necessitated similar erosion rates now, as experienced prior to jetty construction). The sediment volumes required to build and maintain Rosslare Spit are not likely to be supplied solely from erosion of the Rosslare-Carnsore Point tills. The higher erosion rates experienced at Rosslare Strand must reflect the changes in size and position of Rosslare Spit rather than solely on the longer term changes engendered by the dynamics associated with the crenellate bay development of Rosslare Bay. Given the loss rate from the Spit of 38.7 x $10^3/m^3/yr$ over the period 1940-1980, it is clear that alternative sources of sediment, apart from the minor eroding cliff element, have to be considered.

The somewhat inconclusive nature of the jetty evidence prompted consideration of the dynamics of Wexford estuary as a potential factor in the Rosslare erosion problem. In the mid-nineteenth century the shallower intertidal 'sloblands' within the estuary were extensively reclaimed (Furlong, 1970) through the construction of low banks, across the north and south arms of the estuary (Fig. 5), followed by pumping. Within a decade (1845-1855) these reclamation activities halved the high water area of the estuary, although only about 10% of the tidal prism volume was lost. The main effect of these schemes has been to alter the volume of tidal inflow/outflow and hence tidal hydraulics and, as a consequence, the stability of the tidal inlet. It is postulated that the loss of the shallow estuarine areas, including some salt marsh, would have radically altered the ebb tide regime, producing a shorter, more concerted flow. Additionally the discharge from the River Slaney would not have been so readily intercepted and retained by the estuary, so reinforcing the ebb tide domination. The sedimentological consequences of this may be traced from the sequence of maps (Fig. 5) taken over the last 140 years. The shift from flood to ebb bias is reflected in a rapid flushing of the flood material, prograding the ebb delta. This caused two further changes; one, the bypassing efficency of sediment from north (Raven Spit) to south (Rosslare Spit) was impaired, so starving the southern beaches (Rosslare Strand) and causing the progressive withering of the spit in an apparent updrift direction from the distal terminus (Fig. 3), and two, the burgeoning ebb delta and changes in the nearshore of Rosslare Bay prior to jetty construction (Fig. 4) resulted in a major perturbation of the inshore wave climate (Fig. 6). The main change of this being the comparative sheltering of the Rosslare Strand from northeasterly storms allowing the northerly drift of material to accelerate. These two processes together led to the onset of accelerated erosion along the southern shore. The lack of sediment moving south round the ebb tide delta meant a major reduction in the sand accretion to Rosslare Spit's distal end - hence the high rates of erosion.

Conclusion

The main point of this study is obvious: it is dangerous to leap to conclusions as to the cause of coastal erosion problems. The Rosslare study exemplifies this well. The erosion problems of the Bay could be related to any combination of three factors. One, that the shoreline is retreating through natural wasting caused by, perhaps, sea-level rise or changing storminess or by the continuing movement towards some form of wave climate - shoreline equilibrium associated with the crenellate bay morphology. Two, that the reclamation of Wexford Harbour in the 1850s set off a chain reaction manifest today in shoreline recession around Rosslare Bay. Three, that the construction of a jetty in 1880 near Rosslare Point was solely responsible for Rosslare Strand's erosional problems. Option three seems the least plausible, given the existing map and field data, although it has been widely cited as the sole cause, and most coastal defense initatives have been linked to it. At most the changes imposed in the system by the presence of the jetty are only cosmetic in affect. Option one (natural erosion) is hard to assess due to a lack of information, but sealevel stability over the last 200 years at least means that shoreline displacement due to vertical sealevel rise is highly unlikely. Likewise no evidence exists for changing storminess over the last two centuries. As for natural movement to crenellate bay equilibrium - this seems unlikely given the dramatic change in sediment supply and the catastrophic demise of the spit. Option two, associating estuarine reclamation with later coastal change is at least, the most intriguing, and from the evidence presented here, albeit circumstantial, the most likely. There are a number of other sites in Ireland where a somewhat similar pattern of cause and effect can be noted, but as yet they have gone uninvestigated. This is a further reflection on the inexperience of coastal engineers' in Ireland who fail to recognise the interlocking nature of natural environmental systems which appear at first glance to be unrelated.

Lessons for management are easy to accept but hard to implement. Rosslare Bay is now so festooned with coastal engineering structures of varying designs, origins and ages that it would not be easy to restart on a new basis. The chances of facilitating estuary bypassing are slim, given the costs involved, while construction of new defenses would do little to help an already starved beach. The likely prognosis for Rosslare Strand is continued erosion unless a major beach nourishment scheme with all its additional ramifications related to maintenance can be undertaken. Given that this kind of operation has never been successfully undertaken in Ireland and that the cost of the exercise would be considered by Government agencies to be disproportionate to the value of Rosslare Strand, then the future for the site looks bleak. This scenario does not however prevent local property investment being welcomed by Rosslare Strand residents who see its encouragement as a means of forcing Local and Central Governments agencies to undertake even more ineffective remedial coastal protection measures!

Acknowledgements

We should like to thank Mr G. Ford (Wexford Co. Engineer) for his assistance in allowing us access to W.C.C. information. Interpretations of the data are strictly ours alone and do not necessarily reflect W.C.C. views. We should also like to thank Queen's University and the Royal Society for assistance in the preparation of this paper.

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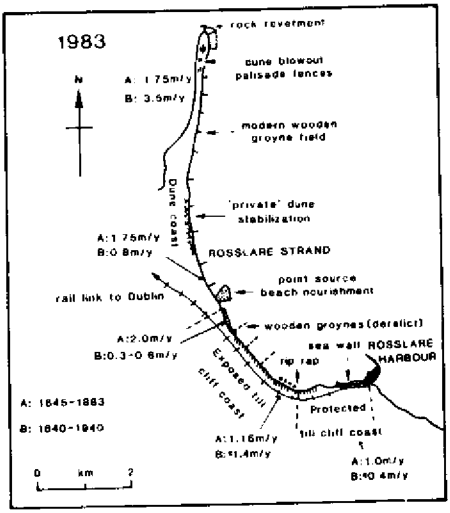

Fig. 2 Coastal units of Rosslare Bay with mean annual shoreline erosion rates and coastal protection measures. Note that data for periods A and B come from Hydrographic and Topographic surveys respectively.

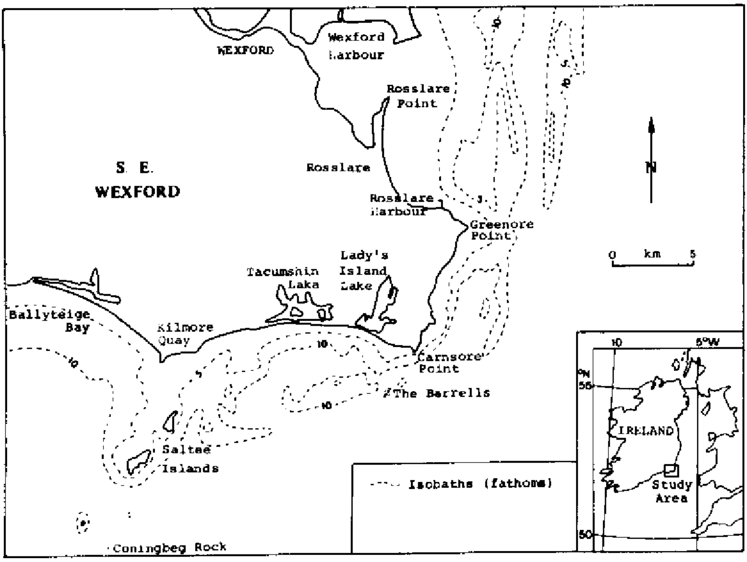

Fig. 1 Location of Rosslare Harbour, Co. Wexford

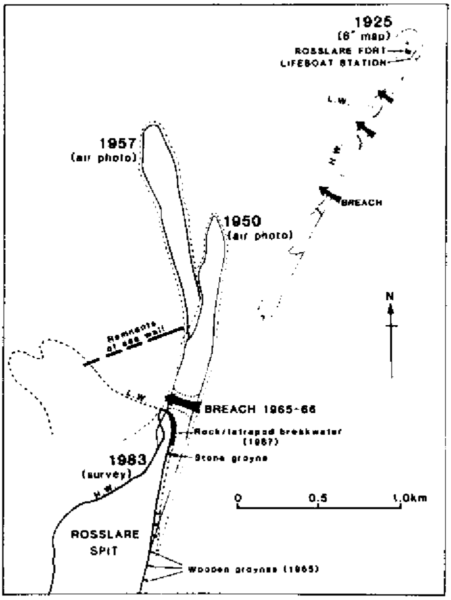

Fig. 3 Changes in the position of Rosslare Spit (1925-1983) based on map and air-photo analysis. Note the beheading and retreat of the spit terminus.

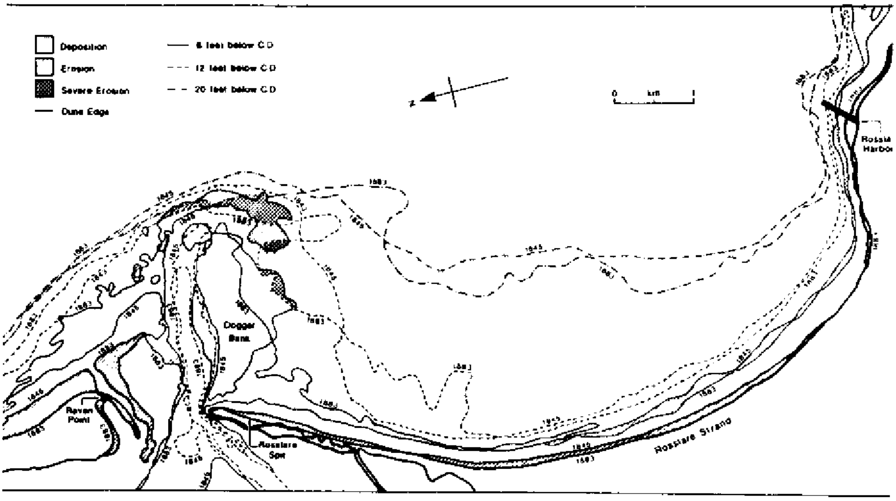

Fig. 4 Changes in the bathymetry of Rosslare Bay during the period (1845-1883), prior to any affects of the first jetty at Rosslare Harbour. Definitions; Erosion: the 1883 contour is landward of the 1845 position. Severe erosion: where the 1883 -20' or -12' contour is landward of the 1845 -12' or -6' contour. Deposition: where the 1883 contour is seaward of the 1845 position. Note the deposition on the northern flank of the ebb-tide delta and the erosion both on the southern flank of the ebb-tide delta, and in Rosslare Bay by 1882.

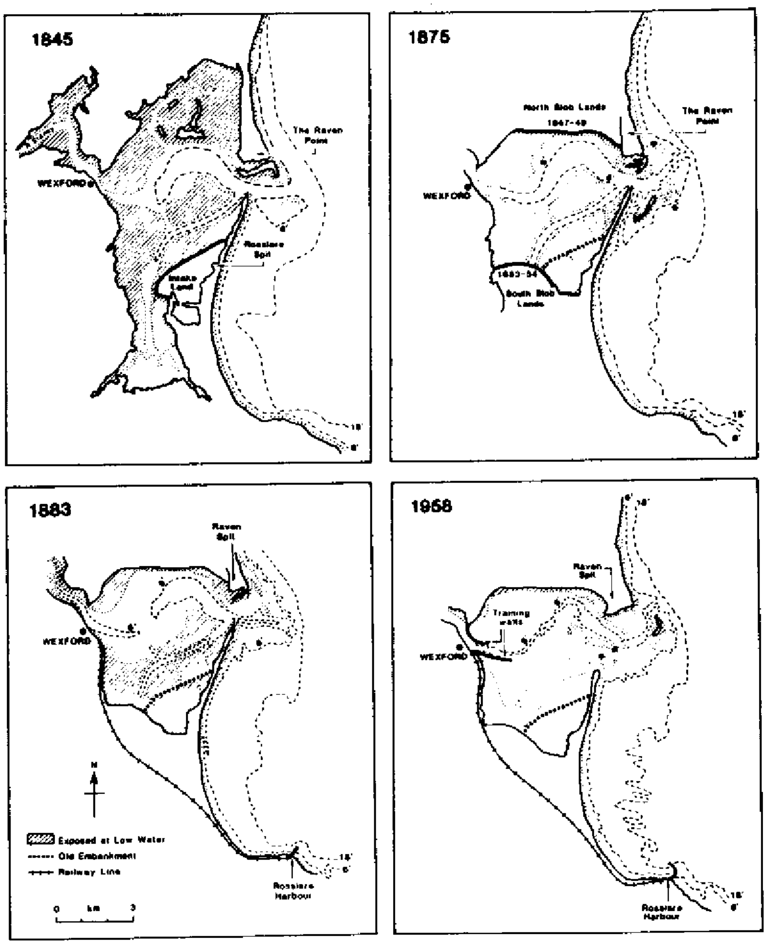

Fig. 5 Changes in the bathymetry of Wexford Harbour and the ebb-tide delta (1845-1958) and the extent of estuary reclamation (1847-1854).

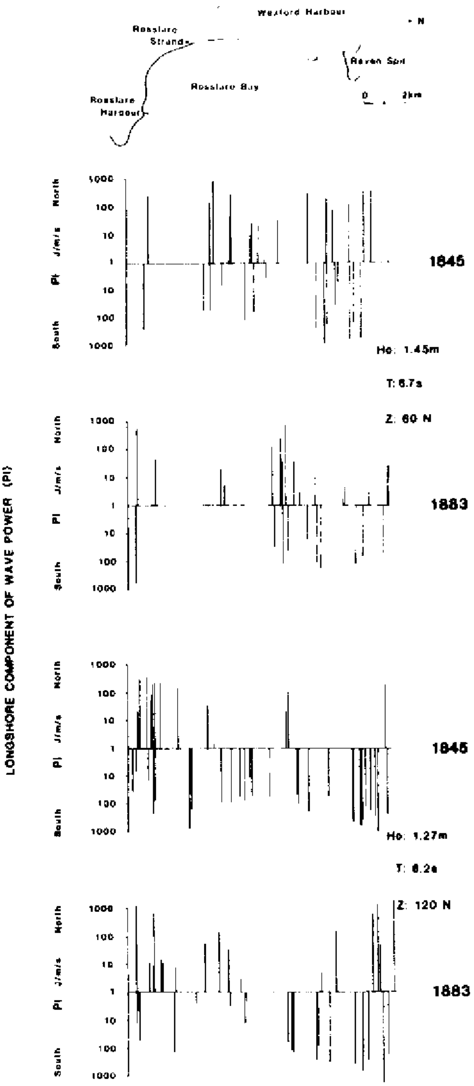

Fig. 6. The alteration in longshore wave power for two wave direction due to bathymetric changes in Rosslare Bay prior to Rosslare Harbour construction. Ho: offshore wave height T: wave period, Z: direction of wave approach. Note the reduction of southerly drift in the lee of Rosslare Bay for both wave directions by 1883.

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LAND USE CONTROLS TO REDUCE COASTAL EROSION DAMAGE IN WISCONSIN

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Introduction

There are three general types of erosion-hazard situations found along the coast of the Great Lakes. The first involves erosion of beaches. Beaches are periodically being worn away in some areas while accumulating in other areas. Structures placed too close to eroding beaches will be subject to flooding and undermining by waves. A second related type of shore erosion involves sand dunes. Dunes protect against wave attack and flooding. Disturbance of dunes and removal of vegetation will subject them to wind and wave erosion and result in a loss of their protective function. Bluff retreat is the third type of erosion hazard. It is the most prevalent and most serious problem in Wisconsin and is the major focus of this paper.

Significant erosion is taking place along almost one-half of Wisconsin's 620 miles of mainland shoreline on Lake Michigan and Lake Superior. On Lake Michigan, short-term recession rates of 3-15 feet per year have been recorded along sandplains and 2-6 feet per year along high blufflines. On Lake Superior, recession rates of 2-5 feet per year are common along blufflines and rates in excess of 10 feet per year have been recorded around bays. As the shoreline recedes, houses and other structures are damaged or destroyed. Damages of over $16 million occurred during the 1972-76 high water period and will increase as erosion continues and additional development takes place in erosion hazard areas.

Causes of Shore Erosion

Wave erosion

Wind driven waves are the primary erosive force on Wisconsin's Lake Michigan and Lake Superior coasts. Beaches are continuously changing as waves add or remove materials. During storms, high steep waves remove beach materials and carry them lakeward. In periods between storms, small waves tend to carry material shoreward and build up the beaches. Waves that approach the shore at an angle create a "longshore current" that runs parallel to the shore. Longshore currents move materials along the shoreline in a process called "littoral drift" that can help replenish beaches. If this littoral drift is blocked, however, rapid erosion may occur.

The extent to which waves and currents erode shorelines depends upon a variety of factors. Among these factors are: storm direction and intensity; wind strength and duration; the configuration of the lake bottom; structures which affect littoral drift; and lake levels. Higher lake levels caused by increased rainfall in the drainage basin or storm surges allow waves to attack the shoreline farther back than usual, greatly accelerating erosion. Lake Michigan varies between a historic high of 580.2 feet and a low of 575.4 feet. Lake Superior levels range from 598.2 feet to 602.0 feet. In addition, a storm surge on the open coast can raise water levels several feet during the storm. In some bays the storm surge can be even greater, reaching four to six feet on occasion. Property owners may build too close to the shore during periods of low lake levels because they believe the shoreline is stable. When higher lake levels occur the protective beaches which normally dissipate the force of the waves are again submerged and waves directly attack the shoreland. Shorelands downdrift from structures which trap the movement of sand, such as groins, piers and off-shore breakwaters, are subject to particularly severe erosion.

Bluff retreat

Wave attack undercuts or steepens bluffs causing unstable slope conditions. Even if wave-induced erosion could be completely halted, bluff recession would continue as the force of gravity acts to move material on the unstable slope to a lower position. Over a long period of time, the slope would reach a stable angle of repose where the stresses acting to move material down the slope and the resistance of the materials on the bluff to these stresses are in balance. The texture (size and shape) of the materials comprising the bluff and the ground water pressures determine the resistance to shearing. The shear stress of the materials in the bluff is primarily influenced by the bluff height and the angle of the slope. Water entering the soil and frost action can further weaken the bluff. Localized ground water conditions may greatly reduce slope stability. When water percolating through the soil reaches an impermeable layer, the water may push material out from the bluff face causing collapse of the overlying soil. Building development and other activities which add weight or water to the bluff also increase its instability.

Most bluff retreat occurs as slope failure, that is, periodic land slides. The most common forms of land slides are slumping and translational sliding. Bluffs composed of silt and sand tend to slough off in shallow layers in the form of translational slides. This occurs when materials moves down the sloping bluff face along a single slide surface in a layer several inches to one or two feet thick. Along some parts of the shoreline, this type of bluff failure is probably the most important. However, it is impossible to quantify the effects of translational sliding without detailed measurement or to predict its occurrence in more than a general sense. Slumps tend to occur in more cohesive materials where a large intact mass of the bluff slides downward in a rotational motion. Slumping usually takes place fairly rapidly and the movement of one slump block can remove up to 50 or 100 feet of bluff top. This type of landslide could result in both loss of like and considerable property damage (Edil and Vallejo, 1976).

The absence of vegetation on the face of a bluff indicates an active state of erosion. Bluffs with an unvegetated face are subject to surface erosion from rain and runoff. Development which removes vegetation, creates impervious surfaces, and increases runoff accelerates this erosion. Ravine corrosion is common along many bluffs. Stormwater drainage from intermittent streams, road ditches, storm drains and other sources of concentrated runoff causes ravines to form. Over time, these ravines may enlarge to threaten structures placed too close to them. Vegetation on the top of the bluff in combination with storm water controls such as earthen berms may intercept and divert surface runoff preventing it from eroding the bluff. In some cases, the amount of material removed by surface erosion may exceed the amount removed by slumps and slides.

Wave erosion, landslides and surface erosion often occur in combination at a particular site. In these cases, attempts to deal with erosion which do not take into account all three of these factors will be unsuccessful. Thus, vegetation and storm water controls will not control bluff recession that is due to sliding and slumping unless the slope has been stabilized. The slope cannot be stabilized unless the toe of the bluff has been protected against further wave attack.

Bluff recession is influenced by many factors. These factors do not occur in a uniform or continuous process over the short term; e.g., wave attack which is related to fluctuating lake levels. After each increment of slope failure the slope temporarily stabilizes until these forces once again decrease slope stability and precipitate another slope failure. A slope may appear stable and become heavily vegetated for a period of years. However, active recession during the life span of a typical building is inevitable for many of the coastal bluffs.

The Structural Approach To Damage Reduction

There are two basic approaches to reducing erosion damages: the structural method and the land use control method. The structural method relies on slowing down the erosion process by constructing devices to protect against wave attack or to stabilize the bluff. The land use control method focuses on adjusting land use to the erosion hazard by setting structures back a safe distance and controlling runoff.

Common structural methods to reduce wave attack are to armor the shore by rip-rap revetments or bulkheads and to build protective beaches by devices such as groins or nearshore breakwaters. Devices to stabilize bluffs including reshaping the bluff to a stable angle and constructing terraces with retaining walls. Structural methods are most appropriate for protecting existing development against erosion. They may also be necessary for protecting sewage treatment plans, ports and other high value new developments which have to be located in the immediate shoreland area. The setback approach is preferable largely because of the limitations of structural attempts from both a private and public point of view. Among these limitations are: (1) Attempts to adequately protect against waves may not be feasible from an engineering point of view, e.g., effective protection may require stabilization of a coastal reach which is longer than the site in question. (2) Structural measures are usually too costly in relation to the value of the land proposed to be protected. The effective life of a structure is reflected in its construction cost. Improperly designed, installed or maintained protective measures will fail and are a waste of money. (3) Structural measures may have adverse off-site effects. Groins may cause accelerated erosion by starving down drift beaches. Shore armorment may deflect waves which erode adjoining property. (4) The form of shore protection most commonly used by individual property owners is loose dumping of stone or concrete rubble. This practice affords only short term protection. Besides destroying the natural beauty of the shoreline, this material often ends up on the bed of the lake, impairing the public rights in navigable waters.

The Land Use Control Approach to Damage Reduction

The land use control approach focuses on the safe location of development in shoreland areas. It adjusts land use to the erosion hazard by the appropriate setback of buildings and other vulnerable uses in erosion-prone areas. Local zoning ordinances and subdivision regulations can require that new development be placed landward of erosion hazard setbacks. Establishing a safe setback involves several steps: (a) identifying the areas subject to erosion; (b) determining shore recession rates; (c) selecting the length of time during which regulated uses are to be protected from recession; and (d) in the case of bluffs, the additional step of estimating the stable slope angle.

There are two basic approaches to determining erosion hazard -- the site specific method and the reach method. The site specific method requires a geotechnical engineering analysis at each site at the time development is proposed. This method may require a report analyzing among other things: (a) wave-induced erosion based upon recession rates and wave energy calculations; (b) geologic conditions including the soils at the site and their properties and stabililty; and (c) groundwater and surface water conditions. While the site specific approach may be technically accurate, it is too costly and time consuming for all but the most expensive development.

The reach method uses generalized formulas to estimate the erosion hazard. Much of the information needed is available from studies made through the Wisconsin Coastal Zone Management Program. Erosion Hazard Area Maps at a scale of 1 inch equals 2,000 feet delineate areas with erosion potential. These maps also show short-term recession rates

(1966-1975) and long-term recession rates at selected intervals. In general, it is preferable to use the long-term rate as a measure of recession. In speaking of the variation over time in average retreat rates, a technical paper of the Corps of Engineers notes: "Thus, the probable error or mean rates and the percent error in mean recession tend to decrease with time. The variance of these estimates would also tend to decrease (thus, the precisions increase) in direct proportion between the number of years between surveys." (Hands, 1979).

Establishing a Recession Rate Setback

A recession rate setback distance can be established by multiplying the average annual recession rate by the assigned design life of the structure to be protected (e.g., 30 years, 50 years or 100 years for a residence). The selection of the appropriate regulatory time span during which buildings are to be protected from recession is a decision to be made by local policy makers in Wisconsin. The State of Michigan requires permanent structures to be set back the distance of the 30 year recession rate, but recommends that a greater setback is desirable (Michigan Department of Natural Resources, 1973). The Province of Ontario measures the 100 year recession rate and the stable slope angle (Ministry of Natural Resources Ontario, 1978).

A 50 year rate appears to be a reasonable minimum figure, since it approximates the useful life to a typical residence. To illustrate, assuming a 50 year design life and a long term recession rate of 2 feet per year; regulated structures would have to be set back 100 feet from the ordinary high watermark. The recession rates shown in the Technical Report Appendices and Erosion Hazard Maps are considered as a general guide for determining the recession rate in a given area. In areas with highly variable recession rates or where structures have accelerated erosion, it may be necessary to make additional studies or to determine the recession rate at the particular site when development is proposed.

Establishing a Stable Slope Setback

Assuming for a moment that no further wave-induced erosion takes place, it is also necessary to determine the additional setback required to locate buildings outside unstable slope areas. The ultimate angle of repose of a stable slope reflects the angle of internal friction of various materials has been documented by engineering analysis. Even though actual bluff failure at a particular site depends upon local variations in the soil profile, groundwater conditions, vegetative cover, surface drainage and other factors, the stable angle of repose of various classes of materials can provide a reasonable rule of thumb to estimate slope stability. Thus knowing the height of a bluff, its slope angle, and the predominant material of which it is comprised takes into account some key site-specific factors.

A generalized stable slope angle of 2½ feet horizontal distance to 1 foot vertical distance (21.8° has been selected for most lake Michigan erosion hazard areas. This figure is based upon studies of relative slope stability of bluffs along Lake Michigan which took into account stratigraphy, parent materials, bluff height and slope angle (Wisconsin Coastal Management Program 1977). In addition, on Lake Michigan slopes of approximately 21.8 degrees (2½: 1), natural vegetation occurs and that vegetation can effectively control many mass wasting processes. The predominantly clayey soils on Lake Superior tend to be less stable. A generalized stable slope angle of three feet horizontal distance to one foot vertical distance (18.4°) has been suggested for regulatory purposes in these areas.

Structures, such as residences, that would be damaged by slope failure can be protected by requiring them to be located outside of unstable slope areas. A stable slope setback for a 50 foot high bluff would be established as follows: An angle of 21.8° (2½ feet horizontal distance to 1 foot vertical distance) is measured from the ordinary high watermark. The point at which this angle intersects the bluff is the edge of the stable slope. This means that the stable slope setback would be 2.5 (stable slope angle) x 50 feet (bluff height) of 125 feet from the ordinary high watermark.

Determining The Erosion Hazard Setback for Zoning

These computations of recession rate and stable slope angle can be used to establish an erosion hazard setback in a zoning ordinance. Within this setback line high value structures which would be severely damaged by erosion or activities which would accelerate erosion can be regulated. Using our previous examples, in an ordinance that required a 50 year period for protection against recession the erosion hazard setback would be 100 feet from the ordinary high watermark for a beach area with a 2 foot per year recession rate. Assume there is another area with the same recession rate but which also has a 50 foot high bluff. Here the erosion hazard setback would be the stable slope setback (50 ft. x 2.5 ft.) = 125 feet plus the recession rate setback of 100 feet or a 225 foot erosion hazard setback line. The erosion hazard setback can be modified if the landowner provides technical data proving that a different recession rate is warranted, slope conditions are more stable than assumed, or that the erosion hazard, although correctly estimated, can be mitigated by structural protection.

Adjusting Land Use to the Erosion Hazard

The damages that will result from shoreline erosion depend upon both the severity of the erosion hazard and the type of land use that will be affected. As the shoreline continues to erode, the land will eventually be lost but the major portion of the damage comes from destruction of structures on the land. Open space land uses such as agriculture, forestry and parks is the most appropriate land use in many erosion hazard areas, other things being equal. However, some facilities such as marinas, water intakes, sewage treatment plants, ports, and certain industries may require a location in the immediate shoreline area. For these shoreline dependent uses careful siting to avoid high hazard erosion areas and well designed erosion mitigation measures are important to avoid unnecessary damage. In the main, these uses are ones for which it may be economically feasible to provide effective structural protection. An investigator of shoreline erosion in Southeastern Wisconsin, commenting on structural erosion protective measures, notes "For the most part, the successful structures observed were built either by units of government or, to a lesser extent, by industry. These structures are massive, well engineered and constructed, and probably much too expensive to be justified for even the most valuable residential properties" (Hadley, p. 27).

Since regulations generally apply only to new development, the effectiveness of regulations depends upon the existing land use development and ownership patterns. These patterns vary widely but may be characterized by the following general categories: (1) rural areas where the land consists of large tracts of open space use in single ownership, e.g., farms and forests; (2) rural areas where the land has been divided into smaller tracts through subdivision plats or sale of individual lots but is not yet developed or only partially developed; (3) suburban areas where the land has been substantially developed along the immediate shoreline and development consists of infilling, i.e., construction on the undeveloped shoreline lots; (4) developed areas where the first tier of lots has been largely built upon and development is occuring within the second tier of lots within an area still subject to erosion; and (5) urban areas where almost the entire shoreline is developed in depth. In general, regulations have their best potential in relatively undeveloped areas.

Relocation and Structural Protection for Developed Areas

Lots already occupied by buildings are largely beyond the scope of regulations. The only appropriate regulatory provisions are those designed to control activities which would accelerate erosion or which control the expansion of structures subject to damage. The owner of an existing structure subject to substantial erosion damage has two basic options: (1) attempt to mitigate the erosion hazard by protecting against wave erosion and stabilizing the slope or (2) relocate the structure. Permanent relocation outside the erosion hazard area could mean moving the structure to the rear of the same parcel if the lot is of sufficient depth, or moving it to a different lot not subject to erosion. "Relocation is an alternative that cannot be overemphasized. Erosion is a natural geologic process that is extremely difficult to stop. The alternative to build shore protection or to relocate must be weighed against the consequence of failure. Depending upon the type of structure you might consider, it may cost the same to relocate as it would to build shore protection. Should a protective structure fail, then your investment in the structure is lost and your home or cottage still in danger" (U.S. Army Corps of Engineers, North Central Division. p. 14).

The following information on relocation costs is based upon 1979 data as presented in the state shore erosion plan. A number of factors affect the cost of relocation. "They include lot depth, the availability of new building sites, ease of site access, building configuration and size, amount of subfloor access, number of public utility disconnections, and the availability of experienced movers. Because relocation is typically only considered during emergency periods, the amount of land lakeward of a building is a critical factor. Between 15 to 20 feet of clearance is normally required for safe operation of equipment. Moving costs of a small cabin or cottage, medium size ranch style house, and large mansion can be expected to range between $3,000-$4,000, $7,000-$9,000, and $30,000-$40,000, respectively. These costs do not include site preparation costs at the new location" (Springman and Born, 1979, p.87).

In cases of individual hardship where lots are too shallow to permit construction meeting the erosion hazard setback, it may sometimes be reasonable to permit a moveable structure such as a mobile home or residence designed so that it can be readily relocated. Allowing such structures within the setback line should be done only on a case by case basis after a careful investigation of the particular situation. Appropriate conditions should be attached to development permission in these instances.

Land Use Controls for Undeveloped Areas

On lots of adequate depth the most satisfactory approach is to properly locate the structure in the first place. This means that structures should be set back a safe distance from erosion hazard areas. The setback should be based upon a consideration of the recession rate, in all cases, and a stable slope angle in the case of erodible bluffs.

Zoning ordinances and subdivision regulations are important tools that local government can use to require that new land uses take erosion hazard into account. Subdivision regulations and zoning complement each other. Zoning focuses primarily on the uses of land, the dimension of lots, and the location of structures on the lot. Lot dimensions are important to ensure the lot is deep enough to permit structures to be safely located behind the required erosion hazard setback line. Zoning can also control grading, filling, vegetative removal, installation of protective devices and other activities that may accelerate erosion. These activities can be made conditional uses to require that they be undertaken in a manner that avoids adverse effects.

Subdivision regulations focus on the process of dividing larger tracts of land into lots for purposes of sale or building. For undeveloped areas which have not been divided into lots, subdivision regulations have particular promise. The larger size of the parcel involved makes it more likely that economically feasible engineering solutions can be found to storm water management, grading and filling and erosion protection measures. Subdividers can be required to designate erosion hazard areas on the plat, and restrict this area to park or open space for the use of the residents of the subdivision.

Sample Erosion Hazard Provisions

Sample erosion hazard provisions designed to supplement local zoning ordinances and subdivision or regulations have been prepared for Wisconsin's local governments (Yanggen, 1981). In general, these provisions regulate erosion prone lands by: (a) establishing an erosion hazard setback line; (b) restricting or prohibiting uses which are vulnerable to erosion damage or which may impair public rights in navigable waters; (c) requiring special review of erosion protection devices to ensure that they are properly designed and installed and do not have substantial adverse environmental impacts; and (d) regulating land disturbance, vegetation removal, runoff and other activities which may increase erosion. Flexibility in the zoning is achieved through conditional use provisions which allow landowners to prove that: slope conditions are more stable than assumed; a slower recession rate is warranted; or that erosion hazards can be mitigated by structural protection or placing a moveable building on the site. After public notice and a hearing on a conditional use, the local Zoning Agency may grant development permission, deny it, or allow development to take place subject to specified conditions.

Subdivision regulations are an important tool for reducing erosion damages and/or protecting potential purchasers of erosion-prone lands. The subdivision regulations contain provisions that allow local government to: (a) require each lot to have adequate area to meet the erosion hazard setbacks; (b) prohibit the subdivision of lands subject to serious erosion unless the hazards are overcome; (c) require the designation of erosion hazard setbacks on the plat; (d) limit the use of hazardous lands through deed restrictions or dedication of the land to the public; (e) review proposals for stormwater drainage, grading and similar activities which may accelerate erosion to ensure they are undertaken in a manner compatible with conditions on the site; (f) require the subdivider to install reasonably necessary public improvements, including erosion control measures or provide a surety that the improvements will be installed; and (g) require that erosion protection measures are maintained by a properly constituted private agency with assessment powers.

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Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ.

ANALYSIS OF BRIGANTINE NATIONAL WILDLIFE REFUGE AREA USING THEMATIC MAPPER (TM) SENSORY DATA

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Abstract

Satellite remote sensing using the new Landsat sensor -- the Thematic Mapper (TM) -- may provide coastal zone cover assessment in a timely and cost effective manner. Thematic Mapper (TM), data (1982) a part of the Brigantine National Wildlife Refuge Area, New Jersey, has been obtained from the National Marine Fisheries Service, Northeast Fisheries Center, Sandy Hook. The objective is to classify the TM information and develop images which can be used to identify existing land cover which may greatly enhance coastal zone management. All seven bands from the TM were used to develop the unsupervised classification of the reflectance values of the associated land cover. The application of the TM with the increased spatial resolution was the primary reason for the study. Additional incentives were to apply information from the blue, mid-infrared, and thermal bands which are unique to the TM sensor. The processing was done using the ELAS software package written by NASA's National Space Technology Laboratory, Earth Resources Laboratory (ERL), Bay St. Louis, Mississippi.

Introduction

New Jersey's Coastal Management Plan was approved in two phases, the first, covering the state's Atlantic counties including Monmouth, Ocean and Cape May, was passed in 1978. Since then, the state has been implementing its coastal plan which includes inventorying its extensive coastal wetlands. One of New Jersey's most diversified wetlands includes Brigantine National Wildlife Area (BNWA) which is part of the Edwin B. Forsythe National Wildlife Refuge. This area encompasses both modified and natural wetlands. The paper reports on the development of an unsupervised classification for a part of the extensive wetlands covering the southern portion of BNWA which is located in Atlantic County, New Jersey, approximately ten miles north of Atlantic City. The study area is bounded on the North by Oyster Creek Road and is located entirely within the New Jersey Coastal Area Regulatory Area (CAFRA). The BNWR northern boundary is the rapidly growing suburban communities of Oceanville and of Smithville (Fig 1).

Many state coastal plans have been hampered by the absence of adequate information to develop a fully integrated coastal zone plan. Consequently, the availability of comprehensive and reliable land cover information will enhance not only the interpretation of the image, but also facilitate the implementation of the management plan. Since 1972, the Landsat Multispectral Scanner (MSS) has provided regional planners and resource managers with increasingly reliable and cost effective land cover surveillance. Many studies, too numerous to quote, have been undertaken in terrestrial settings, yet coastal and nearshore applications have been relatively few except for Klemas and his students. Representative studies dealing with wetlands and biomass surveillance include early inventories of marshes (Klemas et.al., 1979), analysis of stressed wetlands (Klemas et.al., 1983), biomass assessments (Bartlett et.al., 1977 and Bartlett and Klemas 1979a, 1979b, 1981, and Butera, 1983). Other authors have used Landsat remote sensing techniques to facilitate fisheries (Brucks, 1979).

One of the principal problems with the MSS has been its relatively coarse resolution which is approximately one acre. While sufficient for many regional applications, the Landsat MSS system may not be detailed enough for land cover applications in the coastal wetlands where individual vegetative stands may be much smaller.

Landsat Thematic Mapper

The wetland environment by its very nature is an extremely difficult area to survey from the ground, in part because of its inaccesibility (Richardson, 1984) and in part due to the absence of adequate ground truth information. To date, the Landsat system is the only satellite sensor that is even close to having the required surface resolution to study the wetland land cover which is often characterized by highly diversified vegetative cover. This paper discusses the use of the TM sensor, which has a surface resolution of 30 meters, or 0.25 acres, as opposed to the more conventional Multispectral Scanner (MSS). The TM relies on the same technology as the MSS, and records electromagnetic radiation from seven different bands, also referred to as channels, as follows:

1)Blue light	(0.45 - 0.52 micrometers),
2)Green light	(0.52 - 0.60 micrometers),
3)Red light	(0.63 - 0.69 micrometers),
4)Near infrared	(0.76 - 0.90 micrometers),
5)Near infrared	(1.55 - 1.75 micrometers),
6)Thermal infrared	(10.40 12.50 micrometers),
7)Mid-infrared	(2.08 2.35 micrometers) (NASA 1982).

The three new bands are: blue visible light, a mid-infrared, and a thermal infrared band. Another major advance of the Landsat IV system is its capability to communicate directly with the Earth. Data transfer from the spacecraft to the processing center at Goddard Space Flight Center is accomplished by the Tracking and Data Relay Satellite System (TDRSS). Previously, the Landsat systems relied on an onboard tape

BRIGANTINE NATIONAL WILDLIFE REFUGE AREA

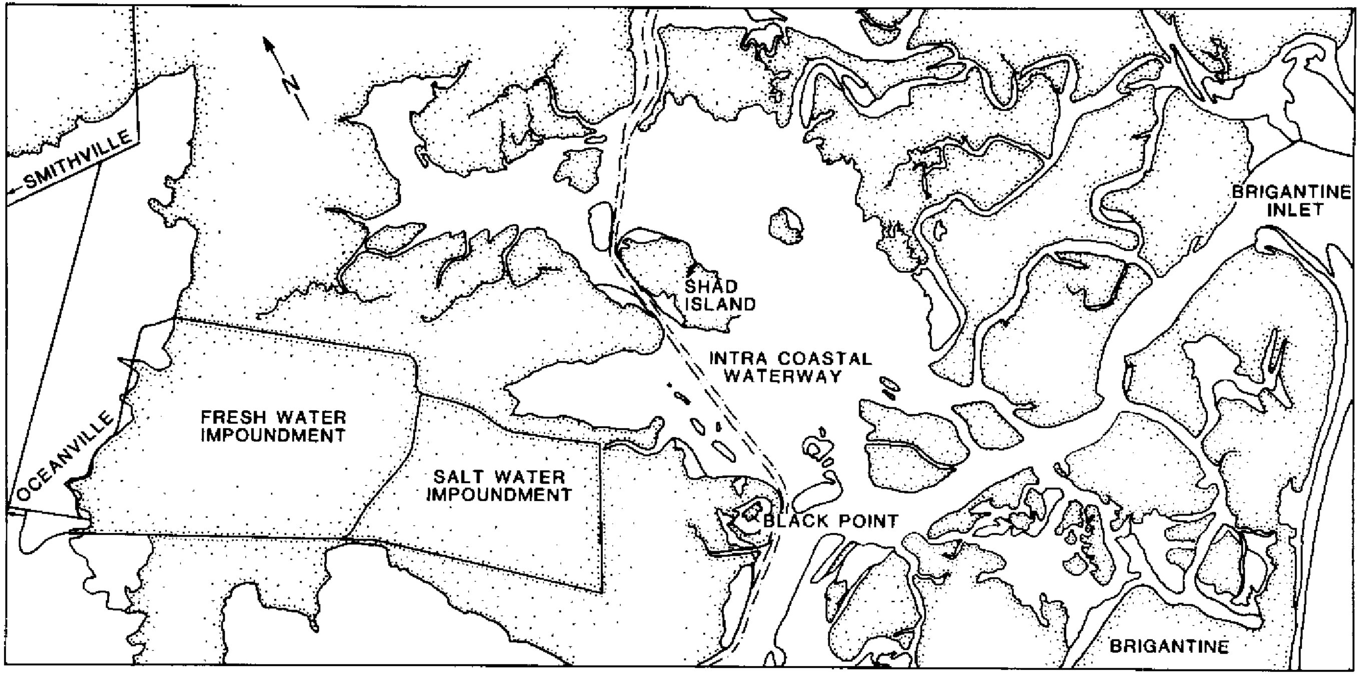

Figure 1: Brigantine National Wildlife Refuge Area

recorder for data storage until the time the satellite over-passed an earth receiving station. These onboard tape recorders had two operational constraints: a limited lifespan, and a built in time delay in data transmission. The Landsat IV provides near real time data reception and a greater orbital life expectancy.

Method

The data used for this analysis was obtained from a small reduction of the TM scene 40150-15084 Row 14, Path 33, dated December 13, 1982. The larger scene is centered over Dover, Delaware and measures approximately 100 by 100 miles and covers an area approximitely 10,000 square meters. The classification used for this paper was based on a subset of the Dover image measuring approximately 12 miles by 12 miles and applied to the center portion of the BWNRA, including the two impoundments immediately to the east of the administration building and extending across the bay and barrier island where it includes the north westerly portion of the borough of Brigantine (Fig 1).

Digital data storage requirements for a whole scene are very extensive totaling 290,858,000 bytes, but the working subset comprised 16,900,096 bytes. The TM data used for this study is considered Engineering Data by NOAA, which does not guarantee for its accuracy.

The Landsat data was processed using the software package developed by Earth Resourses Laboratory Applications Software (ELAS), written by the Earth Resources Laboratory of NASA's National Space Technology Laboratory, Bay St. Louis, Mississippi (Junkin, 1980). The software package is made up of more than one hundred modules, each of which is responsible for a specific type of processing. The software is user interactive and enables the analy ist to develop and manipulate a variety of color image displays. The ELAS software operates under a control file environment, which "keeps track" of all processing results from each module used in the data processing. This information is stored for the user in the control file for subsequent reuse and update. All values stored in the control file by the user can be used by other ELAS modules either as data input or intermediate information which may be required to perform subsequent asks.

The data window for the BNWR include lines 1 to 480 and elements 5550 to 6062 resulting in a window consisting of 512 by 480 pixels. The window was chosen by ingesting the entire scene for channel one through seven, and then selecting the lines and elements which most closely coincided with the physical boundaries of the southern portion of the BNWR. The computer compatible tapes were read using the module that reads the tape and re-formats the data into a disk file for direct access by the other software modules. Each channel of TM data is stored on a single tape, and all seven channels were read in for this area of interest. The specific window parameters are input to the module and then run to read the tapes. The output disk file is formatted by ELAS and the data is read into it for later processing.

Unsupervised Classification

There are two ways in which land cover information may be obtained from a Landsat scene, supervised and unsupervised. The supervised classification requires apriori knowledge of the area to be analyzed.

In these instances, the analysist knows the geographical location of specific land cover types and the associated reflectance values. These signals are then being used to classify all other pixels in the scene with similar reflectance signals. The unsupervised classification refers to a procedure by which a classification scheme is developed using a search routine, which passes a three line by three element window through the data from all seven channels to compute homogeneous training field statistics. The statistical data is stored in a subfile of the control file for later use by other ELAS modules. The spectral

Brigantine N.W.R. classification
Classification Statistics

			CHANNELS						
Class	No.	No. Pixels	1	2	3	4	5	6	7
STAT	1	3087.	101.13	42.94	48.47	49.57	27.33	13.37	63.97
STAT	2	26532.	61.35	23.82	21.89	12.68	6.03	3.76	78.15
STAT	3	1197.	77.16	31.30	32.88	37.40	20.97	10.55	65.69
STAT	4	52650.	58.69	22.61	20.38	11.23	6.29	4.00	85.21
STAT	5	1782.	71.10	28.34	28.96	35.71	19.65	9.57	65.34
STAT	6	36.	139.25	63.28	75.17	72.03	31.03	15.94	63.72
STAT	7	2601.	221.09	103.17	125.98	107.61	29.80	15.89	62.23
STAT	8	69489.	54.47	19.91	17.05	9.81	6.31	4.11	89.71
STAT	9	369.	73.68	29.68	30.11	38.97	17.42	8.48	65.28
STAT	10	1917.	91.36	38.21	42.30	45.65	25.88	12.56	64.21
STAT	11	810.	205.34	95.73	117.56	102.86	33.24	17.76	62.72
STAT	12	513.	81.92	33.68	36.65	40.37	26.17	12.70	64.62
STAT	13	99.	58.15	22.04	20.98	14.75	9.76	5.11	75.51
STAT	14	648.	188.65	87.64	107.70	96.67	33.52	17.66	62.79
STAT	15	207.	172.66	79.57	97.34	88.58	32.92	17.14	63.69
STAT	16	801.	108.77	46.86	53.97	54.09	28.61	14.19	64.13
STAT	17	873.	83.23	34.47	36.74	42.18	22.13	10.80	64.63
STAT	18	432.	76.83	30.95	32.91	35.00	24.94	12.84	66.07
STAT	19	216.	117.64	51.59	60.31	59.70	29.80	14.96	64.36
STAT	20	189.	66.58	26.34	25.96	34.00	17.49	8.56	65.96
STAT	21	324.	101.20	43.17	50.47	53.27	34.78	16.89	64.84
STAT	22	63.	198.27	92.68	112.56	96.65	26.78	14.05	66.54
STAT	23	63.	109.24	49.98	58.87	44.11	8.19	4.87	69.56
STAT	24	207.	71.72	28.38	29.37	31.36	24.00	12.62	67.10
STAT	25	396.	120.49	57.77	68.63	46.64	9.10	5.30	69.04
STAT	26	36.	68.75	28.61	28.14	17.25	5.53	3.28	70.14
STAT	27	135.	102.89	43.83	49.33	49.49	23.27	11.90	65.08
STAT	28	315.	90.57	37.86	41.77	45.60	22.14	10.83	65.10
STAT	29	117.	79.89	32.74	34.42	38.86	17.88	9.10	65.79
STAT	30	81.	89.16	36.89	40.43	42.88	18.91	9.78	66.02
STAT	31	117.	98.66	41.82	46.45	48.01	20.74	10.39	65.67
STAT	32	45.	85.13	35.69	40.31	44.87	29.31	13.96	65.51
STAT	33	27.	169.26	77.70	92.48	79.26	24.07	12.44	65.89
STAT	34	108.	96.54	40.94	47.02	50.06	31.19	14.94	65.14
STAT	35	36.	142.17	64.28	75.28	65.00	22.36	11.83	67.08

(Table 1)

signatures were defined for this classification by the lower bound of 0.1 standard deviation and a standard deviation upper bound of 1.0. Furthermore, the mean value times the coefficient of variation value could not exceed five percent.

The statistical output (Table 1) represents the unsupervised land cover classes that were clustered from this window of data. The final statistical preparation consists of those merged statistics that have the smallest scaled distance between any pair greater than the minimum scaled distance of 3.0. The mean values for each channel (electromagnetic band) are then plotted and the resulting curve is the spectral signature which characterizes each class within the data. This signature data is used in the classification to identify ground cover type by pattern recognition or clustering through the use of maximum likelihood technique. According to Bayes' rule, the pixel is assigned a class value in accordance with the probability of its occurrence within that class. The mean vector and covariance matrix from the training site statistics computed by the search routine (previously discussed) was used to determine the best fit assignment for the classification. Each input pixel is assigned a class from the statistic into which that pixel fits the best. A disk file containing the classified pixels is then written for image display and analysis.

Interpretation

The unsupervised classification produced thirty-five land and water classes (Table 1), twenty-three of which were identified based on information obtained from the Oceanville and Brigantine Inlet 7 1/2 minute quadrangle series. In addition, interpretation was enhanced by vegetative transect made available by the US Fish and Wildlife Service.

Significant man-made modifications have impacted the BNWR and environs. The Intracostal Waterway (ICW) divides the image in two with several old spoil islands clearly in evidence, including Black Point and Shoal Island. The most dominant features are the two impoundments located in the west central portion of the image. The westernmost is representative of a fresh water marsh into which the Doughty Creek drains. A ditched and controlled saltwater marsh environment is located immediately east of the freshwater impoundment providing an environment which differs from both the diked freshwater marsh and the uncontrolled bay environment surrounding both impoundments. Finally, a partically developed barrier island separates the estuarine system to the west from the open ocean.

A total of thiry-five individual classes resulted from the unsupervised classification, twenty-three of which were associated with vegetative covers. For illustration purposes, three examples of black and white "density slicing" are presented in Figs. 2-4. The classification of the combined reflectance values for each of the seven TM bands have been converted to a gray scale rendition in Fig. 2. The specific class associated with a particular land cover is identified by substituting white for that gray scale level for the class. Thus, in Fig. 2, white is substituting a land cover class which on the gray scale has been depicted as dark gray. In Fig. 3, white has been 'sliced through' a land cover which approaches black and which is identified as shallow bay water and associated drainage channels. These areas have little or no emergent vegetation. It will be noted that not all the water has been included in this class. On the ocean side of the barrier beach the shore drops off rapidily identifying shallow water within a

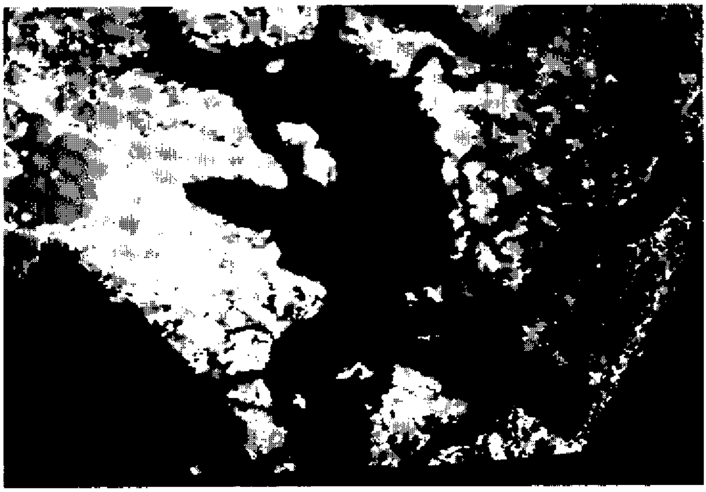

Figure 2

Figure 3

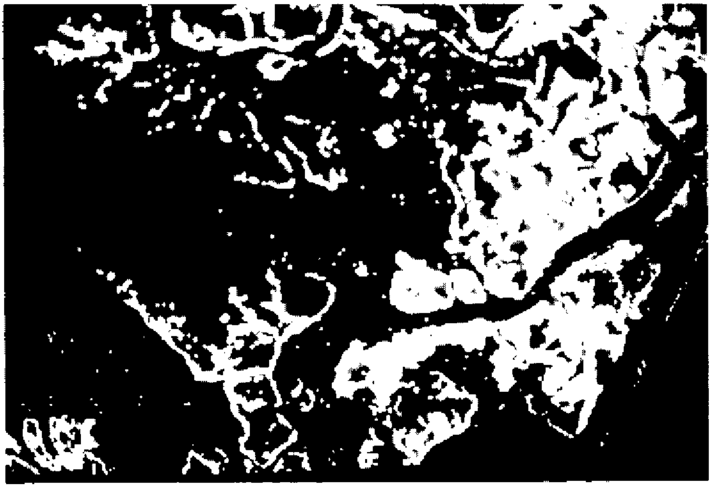

Figure 4

short distance of the shoreline. Conversely, deeper water extends a short distance into the bay through the Brigantine Inlet. Finally, the very shallow water located within and immeditely surrounding the two impoundments have not been included the this class.

The last illustration (Figure 4) shows the extensive emergent marshland vegetation consisting largely of Spartina patens and Spartina Alternaflora which characterizes much of the bay and surrounds the several natural and manmade islands.

Because of high printing costs associated with the publishing even black and white pictures only three of the original 35 land cover classes have been discussed in this paper. A more efficient way to assess land covers requires a supervised classification. This procedure expects geographical land cover information which reflectance range is used to identify areas with similar reflectance values. This procedure is more labor intensive and requires the identification of of several sites for each of the land cover classes to be included in the analysis.

While the application use of the TM sensor is still in its infancy and largely confined to terrestrial sites, there is considerable evidence that this system may be particularly useful in assessing land cover changes in the coastal zone including both the terrestrial and marine portions of this important environment.

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A FLEXIBLE METHOD OF BEACH PROTECTION

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Flexible Beach Protection

The protection of beaches or more accurately, the maintenance of the high water line at an existing location can be effected in a variety of ways. In urban areas such as resorts, a rigid mass concrete structure may be built to ensure the permanence of the adjacent structures.

At the other end of the scale, beaches may be replenished by the dumping of sand either from inland or from dredging offshore sandbanks which may in turn affect the wave climate.

The use of wire enclosed rip-rap, gabions gives a structure that is neither rigid nor completely free to adjust to any level but does, with careful design, offer an opportunity to stabilize the beach at a limited range of levels.

Structures built with this type of material may include bulkheads or walls, revetments and groins or a combination of several types.

Materials Used in Wire-Enclosed Rip-Rap

Modern gabion mattresses are, as the title suggests, fabricated from wire. This is usually mild steel although high tensile steel and plastics have been used but the gabion originated with wickerwork baskets filled with stone or with soil. Uses have been documented back to China centuries ago (1) and to Italy where steel wire came into use only about one hundred years ago.

Mesh for Coastal Structures

Although other types can be used, this paper will refer only to mesh fabricated into a hexagonal shape with a double twist between meshes. This, because of the appearance, has also been designated as "Triple Twist". The wire used, mild steel conforming to ASTM A641A and Federal Specification QQ-461-H, is zinc-coated (galvanized) prior to weaving

Thus ensuring that the coating is uni form. For use in a marine environment zinc-coating is not by itself sufficient protection for the wire which therefore receives a coating of PVC extruded onto it prior to the weaving process. This coating is formulated to resist salt or brackish water, the effects of ultra-violet radiation and frequent wetting and drying.

Rock for Use in Gabion Structures

As with rock for all applications for erosion control, whether as rip-rap or for use enclosed in wire cages, the material must be both hard and durable capable of resisting weathering, abrasion and exposure to wave action. In certain special cases softer material may be used as is the case with a number of structures on the Barbadian coastline where only coral is readily available. In such cases the structures, usually low walls and/or groins, have been built for hoteliers and resort developers with the full realization that periodically the lids will have to be opened and additional material inserted.

This process is only practicable for small walls and revetments and could not be employed in larger projects which would be vulnerable should poor quality fill be used.

Although a fairly wide range of sizes may be used for rip-rap, that used for wire-enclosed rip-rap is much smaller from, say, four inches to twelve inches and for use in a coastal environment where the structure is exposed to wave action an even smaller range is not only desirable but essential. Larger material, over eight inches in any dimension, must not appear in the surface layers and, ideally, should be avoided altogether. This assists in maximizing the number of voids in which wave energy may be dissipated while keeping the void content as low as possible.

Additional Materials for use with Wire-Enclosed Rip-Rap

Although the stone used is, as explained above, fairly small there is often a need for a filter layer between the soil and the protective armour. This may be a layer of gravel, typically a six inch thickness for 1½ inch material or a good quality geotextile, or a combination of both. This compares with the usual requirement for two layers under rip-rap to protect against the same wave climate where the rip-rap is of such size as to necessitate intermediate filter layers.

Geotextiles

When geotextiles are used, considerable care must be taken in the selection of the type to be specified, having regard to the soil type, the method of construction i.e. the fabric must resist impact by falling rock, and the angle at which it is to be placed.

The Design of Wire-Enclosed Rip-Rap or Gabion Structures

At present there is not a large volume of published data on the use of gabions in coastal structures. Reseach was carried out in New South Wales (Brown, 1979) on revetments. Some work was carried out there also in making comparisons between types of mesh (Kabaila, 1979)

Currently research is under way in Grenoble France by Sogreah who are undertaking a major study on mattress revetments under wave action.

The structures may be classified into various types for which design data can be considered.

Vertical Walls or Bulkheads

The use of wire-enclosed rip-rap, gabions, for vertical walls is, of course, quite common both on dry land and along rivers. Generally, designs are as for any mass gravity wall having due regard to the free draining quality of the structure.

However, vertical gabion walls are not usually recommended along the shoreline unless situated above normal high water levels when they may function basically to control the erosion of cliffs by wave action.

Revetments

It is as sloping revetments that gabions find many uses in stabilizing the shoreline. With slopes of one to three, maximum thin revetments may be used to protect the base of dunes, to protect pipeline crossings and to provide pedestrian accesses to the beach.

The design of such revetments was, as previously mentioned, investigated by Brown, in 1979 who came up with the following formula for thickness of the gabions mattress, placed on slopes steeper than 3.5:1.

$$TM = \frac{H_d}{3(1-V)(S_r-1)\ \cot\theta}$$

When H_d is design wave height

S_r is specific gravity of rock fill

V is fractional percentage of voids between filling rock.

For usual quarry stone $(1-V)S_r-1) = 1$

This, can, however give misleading results in certain conditions. Consider a sloping revetment at 1 to 3 to resist waves of maximum height 6 feet.

Assume substituting in the above formula (I) we get:

$$TM = \frac{6}{3x1x3} = 0.66\ A = 8 \text{ inches.}$$

While a lining of this thickness might well be sufficient if the water level does not vary greatly between high and low water mark, it would give rise to difficulties if such a layer were to terminate, as is often the case, with an apron level or set flush into the beach at the toe. There would, with six foot waves, be some risk of the mattress being lifted up onto itself and therefore special attention would be required at design stage to avoid this possibility. Possible solutions would be to carry the revetment into the beach well below the level to which it might scour; to increase the thickness of the lower section of the revetment by 50% or more or the provision of a toe wall.

Indeed, 8 inches does not allow more than two layers of stone and prudence would dictate an increase to, perhaps, twelve inches for structures receiving six foot waves during a few storms each year.

Table 1. Table of recommended thicknesses (for use as a general guide only) See following page

Notes: (1) Not recommended at this slope
(2) Would require special treatment at the toe
(3) Filter layer essential

This table, based on the work of Brown, will become invalid when research by Sogreah is complete and is published by the sponsors, Officine Maccaferri SpA of Bologna, Italy.

In the meantime, it cannot be emphasized strongly enough that it is a guide only and, as in all coastal works, local conditions must be taken into account at all stages of design. As with all wire-enclosed rip-rap structures, but even more vital with coastal work, the mesh when installation is complete must be tight so that the stone will not move under wave action.

Groins

Flexible groins may be used to retain beach material to stabilize beach levels provided it is realized that the sand so retained will not be available to replenish another area. This simple fact is sometimes overlooked in groin projects where massive structures may so interrupt the natural litteral drift that materials are swept into deeper water and are lost to the beach system completely.

For this and other reasons, gabion groin are usually designed with their inshore ends no more than three feet above beach level and the offshore end half of that figure. The cross section is such as to withstand the wave action at the location at which they are built.

Slope	Wave Height							
	1	2	3	4	5(2)	6(2)	7(2)	8(2)
1: 1.5	6	9	12	12	(1)	(1)	(1)	(1)
1:2	6	9	9	12(2)	18	36	(1)	(1)
1:3	6	6	9	9(2)	12(2)	18	36	(1)
1: 3.5	6	6	9	9(2)	12(2)	18	36	(1)
1:4	6	6	6(2)	9(2)	12(2)	18	36	(1)

Gabion groins may readily be raised in height or can have units removed in order to bring them to the desired profile relative to the beach, an important advantage where beaches are in transition.

Spacing is not readily calculated and a careful study made of local conditions carried out prior to the use of any groin system. Gabions have, on occasion been used as temporary structures in order to research the likely results of groins at specific locations.

'ther Gabion Structures

Along the beach flexible gabions may also be used as slipways, as small jetties and for offshore breakwaters. In the first case, slipways, gabions may be placed flush with the beach if the natural slope is acceptable, and then surfaced down to a foot or two below low water with a suitable material leaving the balance of the slipway just in gabions.

Jetties may also be built either as continuous structures or as piers bridged by, say, timber decking. If continuous consideration must be given to the effect of the structure on the littoral drift.

Offshore breakwaters may be built parallel or at an angle to the shoreline. Their function is to interrupt the flow of beach material being deposited on, or withdrawn from the beach thus building up the beach behind each structure. Some very successful uses have been made of this technique but it is not suitable for universal use.

Siting Considerations

One of the major considerations in deciding whether to use wire-enclosed rip-rap is that of the nature of the beach material itself. If the beach is of large gravel which is thrown great distances by heavy wave action during storms then gabions used alone will have a limited life. They can be used for such locations but only if they are additionally protected by, for example, sand mastic asphalt which is compatible with gabions, being flexible and particularly suited to a wide range of hydraulic structures ("Asphalt in Hydraulics: The Asphalt Institute,1976

Of course, similar difficulties can arise if loose rip-rap is placed, say, at the toe of a gabion revetment subject to wave action and it is usually necessary to allow for site clearance in such cases. Of course, where such rip-rap is sited in calm areas or outside the normal range of wave action, it will not present any such hazard.

In areas of natural beauty revetments may present an unwelcome intrusion and in such cases the use of gabion mattresses presents a further advantage. The small interstices readily fill with sand and the structure attracts volunteer vegetation. In some sites the mattresses became lost to view in the course of a year or two.

Conclusions

Although the best coastal defense is provided by nature and ideally nothing should be built that could become endangered because of erosion, structures are necessary for a variety of reasons.

Wire-enclosed rip-rap forms a useful method when neither mass concrete or pumped sand meets the needs. It can be attractive and, with care, become buried with sand and/or vegetation thus giving a natural appearance when this is advantageous.

Although research to date is limited, it is hoped that design data will become available in the near future.

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SEA LEVEL RISE AND SHORELINE PLANNING

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Rates of modern sea level change have drawn the attention of scientists for many decades. Prior to isotopic analyses the issue was subject to speculation and intuition. With the advent of techniques to provide absolute dates of transgression and changes in habitats in the coastal environment, the speculation has been reduced and we now have hard data with which to unravel the past trends of sea level change.

Of course the past data and interpretations are valuable and become even more so if their trends are projected into future predictions. Not all practitioners of these studies, however, believe that the future rates of change will continue to follow the trends of the past. Recent reports from an EPA- sponsored investigation suggest that sea level rise may be increasing and amount to from +0.9 m to +2.13 m by the year 2075 (Barth and Titus, 1984). This is a rather substantial rate of change considering the Scholl and Stuiver thesis that sea level has risen but 1.6 m in the past 3500 years (1967). If the predictions have validity, they forecast significant impacts on our coastal zone and the many activities that occur in it.

Despite the concern espoused in scientific circles about the scenarios attendant to these high rates of sea level change, these seems to be little evidence of reaction from within the planning or management community. There may be several reasons offered for this ostrich-like approach:

1) past sea level changes have been so minor and over such a long duration that they are beyond the temporal scale usually practiced in the planning milieu;

2) the realization of the tremendous magnitude of change is beyond the logical planning process. In this case the temporal scale is so foreshortened that planners feel totally intimidated by its magnitude and are unable to accept its effects.

Independent of whether sea level will rise at the low rate calculation, the high rate, or any rate, it would seem important that any planning or management agency consider the possible impacts of this event on their jurisdiction. May the planners and managers excuse themselves from this responsibility by denying the facts of sea level rise? May they consider a raft of alternatives pertaining to the long-range land use decisions but neglect the possibility that the land surface will no longer exist in its same dimensions or locations in that identical temporal span?

The following discussion is intended to address some of the factual information available concerning barrier island response to sea level rise and to point to elements involved in the planning process. It is meant to apply the sea level rise scenarios to a planning context and in so doing provide the planners with a basis for long-range land use decisions.

General Situation

One model of barrier island development that is appropriate to New Jersey is that of island migration up the continental shelf as sea level is rising. This model stresses the washover and inlet sedimentation processes that transfer sediment from the oceanside of the island to the bayside (Figure 1). The driving forces for the migration are sea level rise and a negative sediment budgets. The effects are a loss of volume from the seaward side of the island, a retreat of the seaward margin, an alongshore transport of sediment to inlet locations and shoal development, and an overland transport to the bayward margins of the island. The past scale of these processes in coastal New Jersey may be interpreted from C^{14} dates (Figure 2) pretaining to transgressions of the barrier islands and their associated habitats. One interpretation is that for each unit of vertical rise in sea level, the barrier feature and its habitats are displaced horizontally in an inland direction on the order of 200 times (Figure 3). It is likely that this proportion is appropriate only for those barriers that are a few hundred meters wide. The larger, wider barriers would not react to sea level changes so readily.

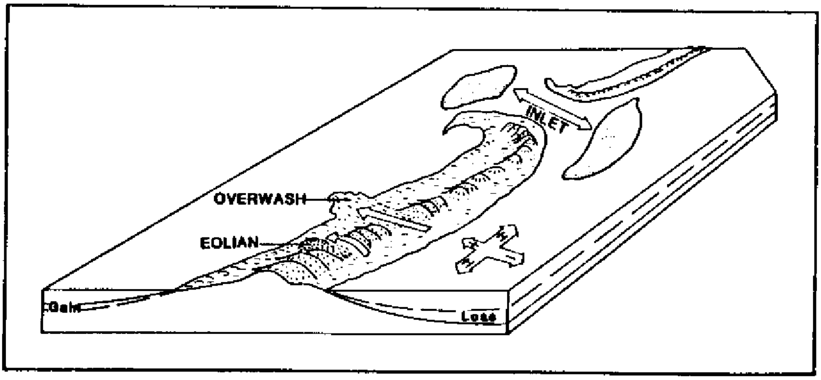

Figure 1. Coastal processes active in sediment budget determination and island migration.

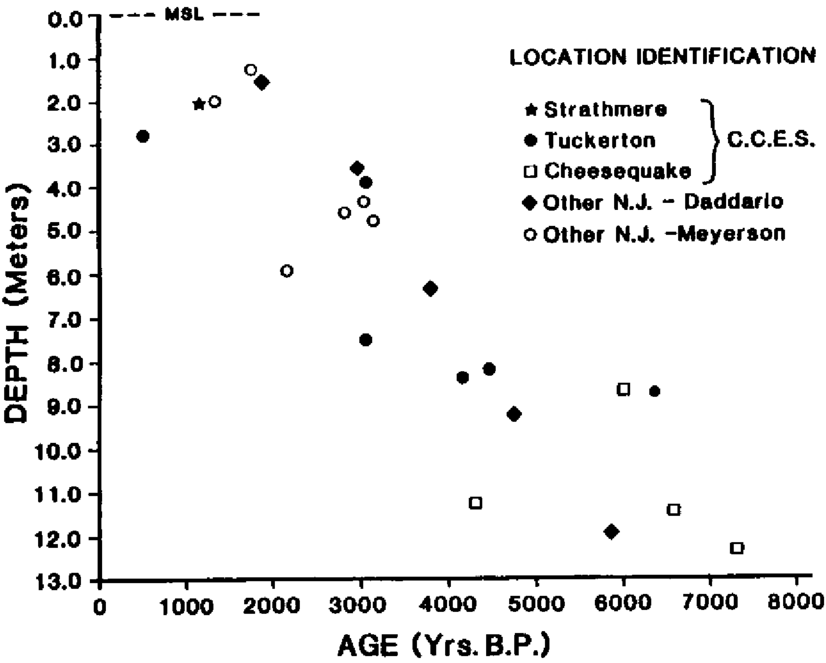

Figure 2. Holocene sea level curve for coastal New Jersey. Source: Daddario (1961); Meyerson (1972); CCES dates collected by Psuty at several locations.

Scale of Change

One of the classic papers in coastal geomorphology, known as the Bruun Rule (Bruun 1962), states that as sea level rises the beach face adjusts to the inundation by drawing sediment from the total beach profile to raise the nearshore bottom. The effect of this translocation of sediment is a farther inland penetration of the new sea level beyond that caused by a simple raising of the water level. For purposes of providing an example of the effects of a one meter rise of sea level on coastal New Jersey, the following representation based on existing data is presented:

Assumptions
- wave base 10 m
- distance to wave base 2000 m
- maximum island elevation 10 m
- width of island 1000 m
- erosion constant at 0.5 m/yr

Conceptually, the Bruun Rule follows this calculation

$$\text{Sea Level Rise} \times \frac{\text{Horizontal Zone of Activity}}{\text{Vertical Zone of Activity}} = \text{Shoreline Displacement}$$

$$1 \text{ m Rise} \times \frac{2000 \text{ m}}{10\text{m}+10\text{m}} = \text{Shoreline Displacement}$$

1 m Rise = 100 m Shoreline Displacement

1 m Rise + Shoreline Erosion = 150 m Shoreline Retreat/Century

If the assumption continues that the 1.0 m rise occurs over 100 years, the affect of the negative sediment budget must also be included for that time period. The erosion value is added to the displacement value and thus for our example in New Jersey the seaward margin of our barrier island will have retreated 150 m in one century. The 150 m shoreline retreat value is a combination of the effects of the one meter rise of sea level and the rate of erosion produced by a negative sediment budget. Other scenarios can be applied in the same manner. That is, a two meter rise will result in a 250 m retreat over a century, and a three meter rise will produce a 350 m retreat.

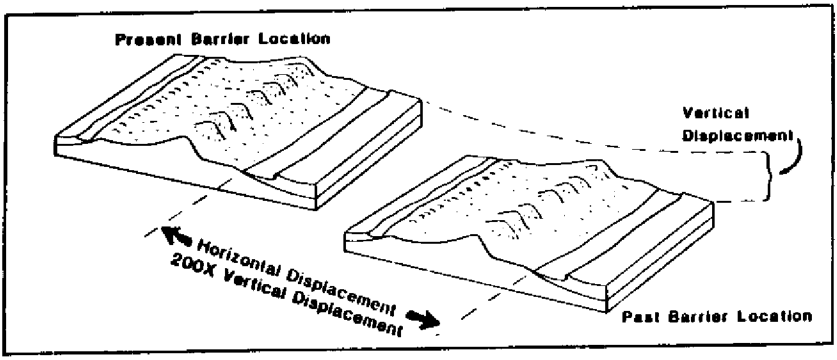

Figure 3. Barrier island displacement as a product of sea level rise in New Jersey.

The Bruun Rule gives us cause for concern if the calculations hold and they seem to be supported by empirical analyses in the Great Lakes relating shoreline displacement with lake level fluctuations (Hands 1984). However, the calculations of island displacement based on C^{14} data from New Jersey point to a 200-times shift. Thus a 1.0 m rise in seal level may produce a 200 m displacement plus 50 m erosion over the period of a century, producing a total retreat of 250 m. The magnitude of such a value can be better appreciated when one considers that even the minor 10 year interval is characterized by a 25 m retreat under this scenario.

Future Barrier Configuration

Given a continuing rise of sea level and a negative sediment budget, there are two barrier island configurations that may evolve (Figure 4). Planners could use these configurations to consider how current and future uses could remain compatible.

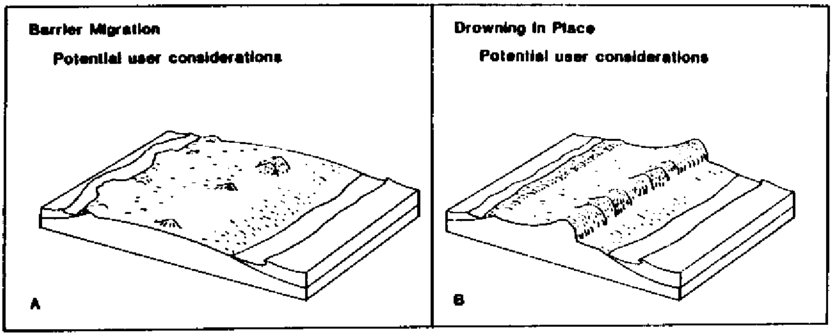

Figure 4. Barrier island change scenarios as a product of predicted sea level rise. A. Migration inland. B. Drowning in place.

Figure 4A represents a low barrier that will be subject to overwash and inlet sediment transport leading to barrier island migration as the sea rises. This island will remain low and broad. Applying the above calculations by way of illustration, the island will migrate inland by 200 m as a result of displacement and will narrow by an additional 50 m because of sediment loss. The island will remain very dynamic with very few high elevations and probably a discontinuous dune line. This would not be favorable location for permanent structures.

Figure 4B points to a situation where natural and cultural factors combine to elevate the island and cause it to remain above the level of overwash during the rising sea level. Given our basic assumptions as outlined earlier, the rise in sea level will remove sediment from the seaward side of the island to compensate for the deeper water in the nearshore zone. The effect of this action will be to narrow the beach and scarp the dunes.

However, the island is being drowned from the bayside as well because the general water level is rising. The overall effect is a rapid narrowing of the island. The bayside of the barrier will probably suffer faster rates of displacement because the slopes of the lee side are normally more gentle than the oceanside. Given this scenario, the barrier will essentially drown in place, actively losing sediment from the oceanside portion and passively losing area from the bayside. Carried to an ultimate, the deeper bayside waters will be sites of larger waves than previously possible and this could lead to additional active sediment loss, thus adding to the rate of narrowing of the barrier island.

Planning?

There is an assumption that planning involves the consideration of a range of possible scenarios and a range of actions to deal with these events. If planning is to accommodate a rapid rise of sea level it seems likely that the scenario in Fig. 4B will be the de facto plan put into effect. A several meter rise in sea level will all but isolate the dunal ridge. However, there will be a limit to the upward growth of the ridge and eventually it may be subject to washover and inlet processes. Planning for this event (not necessarily an eventuality) should be put in effect now if planning is to retain its meaning. Planning should incorporate the variables of:

1. a diminishing spatial base
2. a narrowing beach resource
3. limited development on a high dune ridge
4. increased inlet instability
5. higher wave energy and erosion on bayside
6. total re-evaluation of FEMA insurance zones as the barriers shift and clearance above water level is reduced.

Sea level changes are continuing. There is some question about the rate of change. However, there is no question about the need to consider the logical impacts of this rise in our coastal zone regardless of the magnitude of the rise.

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TIDAL WATERFRONT PROJECTS AND THE NEW JERSEY GREEN ACRES PROGRAM

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ABSTRACT

The Green Acres Program, under the New Jersey Department of Environmental Protection, has been at the forefront of the State's commitment to open up its ocean and tidal waterways for recreational use. Since 1961, 219 acres of beachfront property have been acquired by county and local governments with Green Acres assistance in a total grant amount of nearly $4 million. Over $26 million has been committed to local governments in their efforts to preserve and enhance vital tidal waterfront areas.

The shoreline and waterfront areas are the state's most dominant physical feature. As its foremost natural resource, the shore serves as the state's primary tourist attraction. The Green Acres Program enables the state to work in conjunction with local governments towards the preservation of an extremely valuable and fragile resource.

GREEN ACRES PROGRAM

Like many of you, I have had the pleasure of visiting many of America's and several of Europe's fine beaches. Yet New Jersey offers a diversity which is unique. The opportunities and restraints differ strikingly from Cape May to Monmouth County, from the Delaware River to the Hudson River, but they all share in offering an exceptional visual and physical experience.

The economic, social, environmental and health benefits of preserving and enhancing our open space requires little elaboration. Each Green Acres bond issue since the first in 1961 has included the legislative funding that "the provision of lands for public recreation and the conservation of natural resources promotes the public health, property and general welfare, and is a proper responsibility of government." The very fact that all bond issues have passed by sizeable margins is a clear indication of New Jersey's concern that maintaining and enhancing the quality of life requires open space and accessible natural resources. Through intergovernmental cooperation and strong public support, Green Acres has assisted in the acquisition of over 210,000 acres and the subsequent development of one of the finest public land systems in the county.

In addition, $540 million of Green Acres bond money generated an additional $355 million federal and local expenditures for a total of $895 million for the acquisition and development of open space area.

The gains under the previous four bond issues, although impressive and consistent with state planning recommendations going back to the 1940's, still leave the state several hundred thousand acres short of its objective of 1 million acres of permanently protected public open space (128,000 to be acquired as state land; 261,000 to be acquired by local/county governments).

This need is based on the Balanced Land Use Concept which recognizes that land is a finite resource and that it performs several essential functions such as quality of life, environmental protection and recreational opportunity.

Balance Land Use Guidelines

Municipal - 3% of developed and * developable area of the State
County - 7% of developed and * developable area of the State
State - 10% of state by total area
Federal - 4% in the state by total area *

* area excludes slopes over 12%, wetlands and federal/state owned open space.

The Green Trust and Coastal Resources

Traditionally, the Green Acres mandate included both outdoor recreation and environmental protection. However, since the mid 1970's, with the passage of the third Green Acres Bond Issue which included development funds, a definite turn to recreation over conservation has taken place in the program. Local recreation departments could be fairly certain that any conventional recreation proposal would be funded. This was not a deliberate attempt to circumvent any particular state environmental policy, but a realization, at least at the local level, that municipal governments tend to emphasize user-intensive recreation over conservation measures. (Sandman, 1983)

This concern for conventional recreational facilities have met with much success, and received the backing of professional groups such as the New Jersey Recreation and Park Association. However, the demand for additional open space and a broader environmental awareness has called for an innovative approach to project review and funding. The Green Trust proposal is the result of an indepth review of the state's bonding capacity and present economic and environmental conditions.

In November 1983, New Jerseyans passed the fifth Green Acres Bond which incorporated a Green Trust. The trust makes low interest loans available to applicants for open space acquisition and for development projects which demonstrate sound planning practices and environmental sensitivity while reflecting state-wide recreational needs.

As part of the Green Trust, a priority system has been developed for local acquisition and development applications as a means of judging the relative merits of proposed projects. The system, while in its earliest stages, is designed to reflect the extent to which proposals conform with priorities established by the State Comprehensive Outdoor Recreation Plan (SCORP) and, statewide goals that are consistent with the 1983 Green Acres Bond Act.

Components of this new ranking system include a greater awareness of the environmental ethic and the provision of active recreation opportunities where activities may be best suited to the land area.

This formula works well for those interested in providing a multi-use recreation/environmental experience in the Coastal Zone. Various factors relating to: a) intensity of need, b) balanced land use deficit, c) first time applicant, are given major consideration.

A clear indication of the state's commitment to coastal issues can be found under the project priorities section. Proposals which provide public access (physical or visual) to water, waterfront support facilities, or preservation of unique natural areas such as beaches, dunes, wetlands, or floodplain areas are highly encouraged.

As problems are inherent in any development or preservation project, the goals and issues of each proposal must be weighed against potential conflicts. The following are examples of the issues and activities that are part of the Green Acres funding program. It is hoped that by working in conjunction with other state and federal agencies, Green Acres can continue to assist local communities in providing a unique coastal experience.

COASTAL PROJECTS FUNDED BY GREEN ACRES

I. Wildlife Preservation

Osprey Nests - Atlantic County, Egrets Habitat - Cumberland County

II. Environmental Education

Cattus Island in Toms River, Environmental Center, Wetlands, Wildlife, on Barnegat Bay

Estell Manor, Atlantic County, Solar Environmental Center, several miles of nature trails located on South River. Offers excellent wildlife and vegetation collection of Pinelands/Coastal species.

III. Historic Preservation

Atlantic County, Iron Work Foundry dated during 1700's.

Gloucester County, Red Bank Battlefield - remains of Revolutionary War soldiers and artifacts.

IV. Shore Protection

Berkeley Island on Barnegat Bay. One of the most utilized waterfront parks in central New Jersey. Major feature of park was the need to stabilize eroding shoreline.

V. Economic Development

City of Long Branch is redeveloping its oceanfront to include public promenade and park facilities.

Camden County - Success story on Delaware River. Example of public monies being used to encourage private development.

Bridgeton on Cohansey River, scene of many waterfront festivals.

Highlands Borough, Monmouth County, on Sandy Hook Bay. This bayfront town has been part of a seafood restaurant renaissance.

VI. Water Quality

Point Pleasant Borough, Ocean County, on the headwaters of Beaverdam Creek, last remaining natural area in Point Pleasant and this part of adjoining Brick Township. One of the highest ranking projects to be funded under the Green Trust using new priority system.

VII. Waterfront Access

Seven Presidents Oceanfront County Park, Long Branch, 17 acres of beach and dune in urbanized northern Monmouth County.

Higbee Beach, Cape May County - swimmers, birdwatchers and fishermen frequent the area's mile and a half of beaches and dunes.

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THE BEACH ENVIRONMENT: USER AND MANAGEMENT STAFF PERCEPTION OF THE RECREATION ATTRIBUTES

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The coast is an important natural environment. It is a place for living, working and playing. Historically, from the outset of settlement in the United States, coastal areas have been a focal point for development. Early colonial communities such as Jamestown and Plymouth followed by growth in larger cities such as New York, Boston, Baltimore, Savannah and others exemplify the importance of the coastal zone in this country. Today, the importance of coastal areas continues to increase as evidenced by the amount of new growth and development occurring at this important natural resource. Several demographic trends illustrate this point.

All U.S. coasts together contain the nation's seven largest cities, 53% of its population live in coastal counties, and 90% of its population growth over the past 10 years. It is estimated that 80% of America's population will live on the coast by the year 2000. Forty percent of the nation's industrial complexes are located along its coastline as are 50% of its manufacturing facilities. This tremendous growth in residential, industrial and business use has had a dramatic effect on the amount of remaining undisturbed coastal lands. Coastal wetlands alone have been reduced by 40% and continue to be developed at a rate of 300,000 acres per year. As a result, it has been estimated that only 2% of the relatively undisturbed coastal lands remain in public ownership. (Office of Coastal Zone Management, 1980)

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The restricted amount of remaining coastal lands is important to all potential users. However, the importance is paramount to the recreationist. Presently, each person living in the U.S. spends on an average 10 days per year recreating in the coastal zone. Projected future demand for coastal recreation opportunities nationwide has been predicted to nearly double over the next 40 years.

The limited amount of remaining land for expansion coupled with projected growth in the demand for coastal recreation resources places increasing pressure on those who presently manage recreation areas in the coastal zone to assure that the opportunities they provide meet with the expectation of the users. With recreational opportunities as restricted as those of coastal recourses, the availability for users to substitute an alternative experience may be limited. The consequence of not obtaining a perceived experience by users is dissatisfaction, which can lead to negative repercussions against the coastal recreation facility either overly evidenced by acts such as vandalism or indirectly through lack of public support for the facility. Consequently, for managers of public coastal recreation areas, a knowledge of the users perception of the recreation attributes of the coastal environment is extremely important in meeting their mandated goals of providing rewarding and satisfying recreation experiences for the users, while protecting the natural resource. The research question then arises how well do managers of coastal recreation facilities understand the users perceptions and expectations of the coastal environment?

Past research into the area of perceptional differences between managers and users in the coastal environment is limited, but studies designed to investigate this question at other type of natural resource based facilities seem to indicate a discrepancy in perception exists between the two groups. In highly developed campgrounds, CLARK et al (1971) reported that managers perceptions of camper views appears to be largely a reflection of the managers' own feeling on the issues and are often at variance with campers' sentiments. In forest landscapes, Stone and Taves (1956) point out that the forester sees and explains for forest differently than the recreating tourist. Similarly, Lucas (1964, 1970) reportsthat managers do not rate the quality of resources and facilities the same as users do. Peterson (1974) found that wilderness managers and users had similar dispositions toward the resource but varied in a number of areas including attitude and management preference style. Going on beyond the question of difference between management and users preference, prediction studies that have been completed indicate that managers are unable to predict user preferences. Hendee and Harris (1970) found that managers could not predict users' attitudes of wilderness. In a study of managers' ability to predict user motivation at two national park sites, WELLMAN et al (1982) report that managers of more traditional parks are more apt to correctly predict motivation than are managers of non-traditional parks (i.e., wilderness areas, beaches,etc.).

The findings of previous perception research would indicate that managers may not fully understand the user in terms of what attributes are important to the users' recreation experience, consequently, managers may not be providing the recreational experience users desire.

In coastal areas, due to the constraints of the limited potential for future growth of facilities and the increasing user demand within the coastal zone, recreation areas specifically beaches, cannot absorb user dissatisfaction due to managers not knowing or misinterpreting users' perception of the attributes of the beach.

In an effort to further examine how different user groups perceive the coastal environment a research study was developed to identify the perceptional differences of beach users and management staff towards the recreation attributes of the beach. Specifically, three research questions were asked:

(1) What recreation attributes do users perceive as important in the beach invironment?

(2) What recreation attributes do management staff perceive as important in the beach environment?

(3) Can management staff accurately predict those recreation attributes that users perceive as important in the beach envoronment?

During the summer of 1982, 300 beach users and 99 management staff at 3 New York State park beaches located along the southeast shore of Lake Ontario were personally interviewed. The beach user group was composed of both weekday, weekend, day, and overnight visitors. The management staff group included park managers, office staff, park rangers, life-guards, and maintenance personnel. The rationale for using this composite management group was that each subgroup intereacted with the beach and users in different ways providing unique insights into under-standing management perception of beach users. The decision to use onsite state parks beach employees was based on the idea that onsite employees would have a better understanding of park users since their job required daily contact with users. Upper level administrators, it was assumed, would use information from the onsite staff to assist them in making management decisions that affected the beach.

During the personal interview, beach users were asked to evaluate 20 beach attributes based on the importance of those attributes to their recreation experience at that beach. Management staff, were also asked to evaluate the 20 beach attributes based on their own personal per-ception. In addition, management staff was asked to evaluate the attributes a second time based on how they predicted users would respond. The 20 beach attributes were: beach facilities, large number of people at the beach, preservation of the natural beach environment, safety, water conditions, beach conditions, visual quality of the beach land-scape, distance travelled to the beach, entrance fee, socializing, relaxing, beach activities, solitude, weather, beach development, passive watching, sensory attributes, wildlife at the beach, beach employees, and rules.

Subjects response to the twenty beach attributes were evaluated using a multi-attribute model. The potential advantage of a multi-attribute model over a unidimensional overall effect approach is the multi-attribute model's ability to provide insight into an individual's belief as to the level to which a specific object possesses certain attributes weighed by the importance of each attribute of that object to the individual. (WILKIE & PESSEMIER, 1973). Simplified people evaluate products, landscape, activities, ideas,etc. on two levels: (1) overall belief about the item in reference to suitability or desirability, and (2) attitude toward the importance of each of the item's components fixtures or characteristics. These attitudes presumably combine or summate to produce an overall attitude towards the item (MYER & ALPERT, 1968).

For the purpose of this study a multi-attribute model was designed to specifically measure respondents perception of the importance of the beach attributes. The model can be described as follows:

$$A_{I_K} = \sum B_{I_K} W_{I_K}$$

Where: I = attribute
K = respondent

Such that:

A_{I_K} = perception of attribute I by respondent K
B_{I_K} = respondent K belief about importance of attribute I
W_{I_K} = strength of importance of attribute I by respondent K

The questionnaire used during the personal interviews to collect the data reflects the theory the multi-attribute model is based on. The 20 beach attributes were placed on the questionnaire in statemtent form (i.E., safety while at the beach is important to my recreation experience at this beach). Subjects first evaluated these statements using a five point Likert Scale that ranged from strongly agree to strongly disagree. After all 20 attributes had been evaluated using the Likert Scale, the subjects were then instructed to take an imaginary $100 and to buy those attributes which were most important to their recreation experience at the beach (this procedure was based on the constant sum scaling). Subjects could divide the money among attributes in any manner they wished, but they must spend exactly $100.

The Likert Scale measurement represents the B_{IK} component of the model while the constant sum scale equates to the W_{IK} factor in the equation. Likert Scale responses were converted into numerical values (strongly agree = 5 to strongly disagree = 1) and multiplied by the constant sum score (dollars spent on that attribute) resulting in a respondent's perception score for each attribute (A_{I_K} component of the model). For group evaluation of a particular attribute, total respondent scores for that attribute were summed to produce a composite score.

Example 1 depicts how the multi-attribute model was used to derive the attribute statement evaluation score for the attribute safety. From the composite scores, the 20 attributes were ranked in descending order of importance for each group (users, management staff, and management predictions). Table 1 shows the composite score ranking of the attributes by the three groups.

The results showed that response to individual attributes ranged from complete agreement to almost total disagreement about the importance of the attributes. A few examples help exemplify the results. For the attribute safety users, management staff, and management predictions, all similarly ranked this attribute as the most important. However, preservation of the natural beach, the second most important attribute ranked by users was ranked 6th by management staff's personal perception and when asked to predict how users would rate it, management staff thought users would rank preservation 15th of the 20 attributes. Conversely, for the attribute entrance fee, management predicted users would rank it 4th in importance, when in actuality, they ranked it 12th. Management personally ranked it 14th.

Comparing the group ranking for all the attributes provides more insight into the perceptional differences between groups. (Correlation between group ranking of the beach attributes can be seen in Table 2).

Table 2. Spearman Rhos for Beach Users, Management Staff and Management Staff Predictions Composite Score Means

	Users	Mgt. Staff	Mgt. Predictions
Users	1.00	0.88	0.65
Mgt. Staff	----	1.00	0.69
Mgt. Predictions	----	----	1.00

From a qualitative perspective, some observation can be made about the differences in ranking between the groups. Overall, the ranking results showed that beach users and management staff perceptions were similar having only five attributes that varied by more than three ranking places. For three of these attributes preservation, relaxing and sensory attributes users perceived them as more important than management staff, while the results showed just the opposite for the beach employees and wildlife attributes. The results from management staff predictions of how users would rate the attributes showed seven attributes that differed in ranking by more than three ranks from that of the beach users ratings. Specifically, management staff predicted users would rank the attributes, rules, entrance fee, development and large numbers higher than they actually did, while underrating users perceptions of the preservation,

EXAMPLE 1

ATTRIBUTE STATEMENT EVALUATION

Hypotheical response of one subject toward the attribute: Safety

$$A_{I_K} = \sum B_{I_K} W_{I_K}$$

PART 1

LIKERT SCALE

B_{I_K} = respondents K belief about important of attribute I

	Strongly Agree (5)	Agree (4)	Neutral or Undecided (3)	Disagree (2)	Strongly Disagree (1)
Safety while at the beach is important to my recreation experience at this beach	X				

PART 2

CONSTANT SUM SCALE

W_{I_K} = strength of importance of attribute I by respondent K

$100 to buy attributes most important to individuals beach experience

Safety	$45
Beach	$35
Relaxing	$15
Solitude	$5

PART 3

ATTRIBUTE STATEMENT SCORE

A_{I_K} = perception of attribute I by respondent K

Likert response (B_{I_K}) = strongly agree = 5

Constant sum response (W_{I_K}) = 45

Attribute statement score (A_{I_K}) = 45 x 5 = 225

225 = Attribute statement score of one person for the attribute safety

TABLE I

Beach Users, Management Staff, and Management Predictions: Composite Score Ranking

Attribute Statement*	Users	Mgt. Staff	Mgt. Pred.
Safety while at beach	1	1	1
Preservation of the natural beach enviornment	2	6	15
Weather while at beach	4	5	3
Facilities (picnic tables, grills, etc.)	5	2	2
Relaxing	6	12	12
Water Conditions (temperature, waves, etc.)	7	8	7
Employees (people who work at the beach)	8	4	9
Visual Quality of the beach scenery (landscape)	9	9	18
Rules and regulations concerning people's behavior on the beach	10	7	6
Beach conditions (texture of sand, etc.)	3	3	5

Continues

TABLE I (Continued)

Beach Users, Management Staff, and Management Predictions: Composite Score Ranking

Attribute Statement*	Users	Mgt. Staff	Mgt. Pred.
Socializing (with family, friends and others)	11	10	11
Entrance fee (cost of gaining entrance to the beach)	12	14	4
Activities (swimming, games, etc.)	13	13	10
Development (ways in which the beach has been developed)	14	11	8
Sensory Attributes (sounds, smells, etc.)	15	19.5	16
Distance from my home to the beach	16	17	14
Solitude	17	16	20
Large number of people on the beach	18	19.5	16
Passive watching (watch people on beach)	19	18	17
Wildlife (opportunity to see wildlife at beach)	20	15	19

*All twenty statements were followed by "is/are important to my recreation experience at this beach" on the questionnaire.

relaxing, and visual quality attributes. Finally, when comparing management staff own personal perceptions of the attributes with how they predicted users would respond, eight attributes were shown to vary by more than three ranking places. Managers ranked the attributes preservation, employees, visual quality, solitude and wildlife higher than their predictions of user response while ranking the entrance fee, sensory and large number attributes lower.

The results of this study indicate that beach users' and management staff had similar perceptions toward the recreation attributes of the beach. However, management staff did not appear to be able to accurately predict how users at the test beaches would perceive the attributes. Additionally, management staff's prediction of users response was not related to their own personal perception of the beach attributes. The results may partially be explained by the management staff demographics.

In past perception research that compared users to managers, the manager group was made up of mainly trained professional natural resource managers who, it can be assumed, possessed some past work experience. In this study, 85.8% of the management staff subject group worked six months a year or less (58.5% worked three months a year less). Over 72% had three years or less (35.3% one year or less) of prior work experience at the particular test beach. By age, 73.7% were 30 years old or younger (45.5% were 20 years old or younger). These demographics would seem to indicate that the management staff group for this study was composed of summer employees who were probably students or recent high school or college graduates (28.3% completed high school, 35.4% 1-3 years of college, 12.1% completed college). Although aware of their operational job responsibilities, these young employees would not have had sufficient education or experience to develop a natural resource management consciousness or stewardship that can be seen in the responses of managers in other studies. In fact, due to the newness, or lack of continuity, in their job role, many may base their perceptions of the beach primarily on their years of recreating experience at beach environments (62.7% had made 6 or more previous visits to beaches). The result being that many of the management staff subjects may be responding as beach users, not having sufficient natural resource management education or experience to influence their response.

Similarly, findings in past natural resource perception studies showed that managers incorrectly predicted users' perception because they based predictions of their own perception or misinterpreted user behavior, attitudes, motivation, etc. In this study, the findings indicated that users and management staff perception of the beach attributes, were similar. If management had used their own perception of the attributes, they would have more correctly predicted users response. However, management staff possibly due to the lack of national resource education or job experience background was unable to recognize the similarity between themselves and users and consequently, may have attempted to predict user response using a management perspective they did not possess. The implications of this research would indicate that if management at beach recreation areas base decisions that affect that resource on what they think users like and dislike alone, then they may not be providing the type experience users are looking for in the beach environment. If no other information is available about the users at a particular beach, management staff may well do better to make management decisions based on their own personal perception of the beach, especially if the staff is young and lacks job experience, rather than using some innate understanding management believes they have about the users.

Coastal lands provide an attractive setting for business, residential, and especially recreational activities. Each year, the remaining amount of relatively undisturbed coastal land experience more pressure from competing uses. With growing demand for public coastal recreation opportunities, it has become paramount that those providing such experiences meet the perceived expectations of the users. The consequence of misreading users perceptions is dissatisfaction which may result in negative impact to the resource. Only through a conscious effort by those managing public coastal resources to understand the perceptions and expectations of the resource user can the dual mandate of protecting the resource and providing a satisfying recreative experience be achieved.

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USER ANALYSIS AS A TOOL FOR IMPLEMENTING CHANGE AT BEACHFRONT PARKS

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INTRODUCTION

Public participation is a vital element in recreational planning and design. It provides a means for citizens to contribute their skills, expertise, and resources in developing and/or renovating park areas as well as providing an opportunity for voicing personal needs and/or community priorities relating to park projects (Kaplan, 1980; Gold, 1981).

Meaningful public participation, however, is a difficult task to achieve. Personal and professional constraints relating to time, energy, and knowledge often prevent many citizens, including key decision-makers, from effectively assessing park phenomena in their communities. To counteract these limitations, new avenues of data collection and presentation (Whyte, 1980; Gold, 1981; Rutledge, 1981; ASLA, 1982) are being sought to help non-professionals assimilate information on park conditions more efficiently. This, in turn, would assist decision-makers and concerned citizens in passing judgements that ultimately affect park design, management, and use.

In this study, user analysis and documentary film was used to assist citizen groups in understanding the behavioral context in which two beach park areas were being used. Since the techniques involved systematic and objective analyses of use at the parks, information presented to the citizens was scientifically verifiable and extremely helpful in clarifying the nature and extent of park problems. Such information was then used to suggest changes for the parks in terms of design and management.

This paper focuses on the combination of techniques that are believed necessary to: 1) insure a comprehensive assessment of site characteristics and behavioral phenomena in a park area; 2) allow for an objective presentation of information relating to the site and its management; and 3) facilitate the dissemination of the information to the public for review and comment in time-efficient manner. The techniques involved both traditional forms of data gathering (e.g., site assessments, citizen surveys and interviews) and information dissemination (e.g., public information program, technical reports) as well as two rather non-conventional means for understanding the nature of park areas (e.g., user analysis and documentary film).

Methodology

In most work relating to the rehabilatation of existing park areas, data to be gathered will focus on three major areas: 1) site analysis; 2) user analysis; and 3) management analysis. Each of these areas of information generally rely on several, time-tested, traditional approaches to data gathering (Gold, 1981; Christiansen, 1977; Rutledge, 1971), and many of these methods utilize secondary data sources. It is this latter fact that has proved to be the weakest link in much of the park rehabilatation, design or planning work to date. This is because the use of secondary data tends to encourage fewer on-site visits; thus, the planner or designer fails to understand the behavioral context in which parks are used.

To address this shortcoming, we tested several non-conventional data gathering and information dissemination activities that required user-analysis and documentary film. The purpose was to assess the additional costs related to the activities and the benefits of the data gathered for redesign purposes. A review of the methodologies used to examine each of the information areas listed above serve as the focus of this paper.

Site analysis

Site layout. Traditional approaches to the development of a basemap for a site often involve the use of aerial photographs and USGS topographic maps (same scale). The most recent aerial photographs are overlain with tracing paper and major features (e.g., roads, park boundaries, vegetation, architectural structures) are recorded. Likewise, an overlay of topographic features is produced. Each overlay is then enlarged or reduced by photographic processes (or through the use of a pantograph) to reach the scale desired. The overlays are then combined to produce the basemap of the study area. The problem with aerial photographs and USGS topographic maps is that they become outdated in intensely used or rapidly developing areas. Therefore, they must be field-verified through actual on site surveying to issure accurate basemap production.

The cost of professional surveying currently averages about $400.00/acre; this includes topographic as well as structural characterization of the site. In our study, budgetary constraints required us to use a combination of recent aerial photographs, surveys and select field transect data to develop the basemap. Approximately, ten hours were used to develop the overlay of the aerial photograph; two hours to transfer USGS topographic survey data to the overlay; and ten hours to selectively run transects to verify the basemap data.

Once our basemap was developed, we used old aerial photographs, newspaper articles, and surveyor information to characterize the nature and extent of physical change occuring at each of the beach park areas over time. This helped citizens visualize how current conditions evolved at the sites, and what types of future changes could be expected. The collection and comparison of old aerial photographs, newspaper articles, and surveyors notes took approximately twenty hours to prepare and record on super 8mm film.

Total cost for this phase of data preparation included: twelve hours for traditional basemap development and thirty hours for non-conventional data verification, preparation, and documentation. The benefits derived (above and beyond traditional methods) included a field verified basemap; pictorial documentation of site changes over time; a historical overview of the human dimensions affecting or affected by physical changes in the sites (from news accounts).

Physical Inventory. Physical inventories of site conditions relating to facilities and use areas have traditionally involved on-site assessments. In this study, we did not deviate from this approach except to document site conditions on film whenever possible. The site inventories included assessments of the physical, functional, and aesthetic qualities of the parks; inventory work took approximately eight hours to complete. Two of those eight hours were used to photograph the facilities and use areas. Five additional hours were needed to use the photographic materials in the documentary film.

Total cost for this phase of the site analysis: 6 hours for traditional physical inventory; 2 hours for photographing inventory subjects; 5 hours for preparing the film for documentary use. The benefits derived from the non-conventional data collection included: permanent records of the physical conditions of the sites on film; reference material to gauge assigned assessment values; film to illustrate some of the problems with the sites.

User analysis

Traditional park visitor assessments tend to employ questionnaires (both on-site or mail-delivered) to determine levels of use, patterns of use, and user profiles for select park areas. In this study, we administered an on-site survey to park visitors to assess these three areas of concern, but we also employed several other, non-conventional user analysis techniques to verify the survey information and to provide information on behavior that the survey could not provide.

The survey asked questions about frequency of use, group size and composition, overcrowding, and physical, social, or managerial problems with the site. The cost of the survey work was: 20 hours survey preparation; 31 hours for pretest administration, coding, computer analysis and revision; 98 hours survey administration, coding, computer analysis, and interpretation; 10 hours table and figure preparation for reporting purposes.

This data was corraborated with data from: 1) time-lapse photography; 2) personal observation; 3) visitor mapping; and 4) traffic counts (automated and non-automated).

Time-lapse photography. Two Canon XL-S514 movie cameras were inconspicuously set at high points in each of the park sites; a three second interval was used to record major areas of use and overall patterns of movement. Results of the filming showed intense use of the park areas by motorized vehicles; areas of conflict between motorized and non-motorized beach users; levels and location of use relating to park structures or use areas (e.g., cabanas, picnic tables, boat ramps, parking lots and roads, beach areas, etc.). Where interesting use levels or behaviroal patterns showed up in the film, additional filming (non-interval) or personal observations were used to further characterize the use and/or user group.

Additional cost of time-lapse photography (8 days filming; 10 hours/day) in man-hours was approximately six hours; most of the time was used to set-up and take down cameras and change film. However, over 20 hours was used to review the films, and another 20 hours was needed to edit and splice films for documentary film purposes.

Benefits derived from this activity: pictorial presentation of behavioral patterns and use levels that could be directly linked with site design and/or management problems; permanent record of use on film; corraboration and enhancement of information derived from other data collection efforts.

Personal Observation and Mapping. These techniques recorded various aspects of user groups and patterns of use in the park areas. Both methods provided data with greater detail than the time-lapse photography allowed. Personal observation was specifically used to: 1) characterize the occupants of vehicles entering and passing through various checkpoints in the parks; 2) identify the nature and location of social groups engaged in various activities while using the parks; 3) characterize use of park facilities and length of stay by individual groups within the park.

The cost of personal observation and mapping is high in terms of man-hours because of the demand for continuity in the activity. We used four observers, ten hours/day, for six day s to gather data on the visitor. This amounted to 240 hours of on-site observation work. Analysis and preparation of the data for filming or technical report purposes took an additional 30 hours; and observation training to insure the comparability of data among observers took 3 hours. Therefore, 273 additional hours were used in this phase of non-conventional data collection. The benefits, however, appear worth the effort for several reasons. The results brought survey, time-lapse photography, and traffic count data into context with actual on-site behavioral phenomena; it provided the basis for representation of levels of use, types of use, and social groups composition in a spatial context; and it identified facility and use area attractions and deficiencies due to the detail of data collection.

Traffic Counts. We used automated highway traffic counters to characterize major and minor ingress and egress points at the park sites as well as use levels for various areas along park roads. This data was coupled with personal observation work that characterized occupants of motorized and non-motorized vehicles in the parks; their location and use of park facilities; and areas of conflict. What the automated traffic counters provided in numbers of cars passing a checkpoint over time, personal observation filled in with qualitiative data about the user. For example, we had recorder tapes that indicated over 300 cars passed an ingress point during a 15 minute interval; however, personal observation allowed us to determine how many people (adult and children) occupied those cars. Time-lapse photography enhanced the data further by allowing us to determine how many of those vehicles were repeat visitors--i.e., cruising the beach roads and not using other park facilities.

The man-hours of work involved in traffic-counting was approximately 45 hours (four counters, 15 minutes/day, 45 days). An additional two days of observation work was used in conjunction with the traffic tapes (4 people, 2 days, 8am-6pm). Twenty hours of data analysis and preparation for filming (and technical report) were required. Therefore, approximately 185 hours of work went into this phase of the study. Benefits derived included: diurnal, weekly, holiday/non-holiday levels of use for the two park areas; intensity of use by different user groups on a spatial basis within the parksites; permanent records of use levels for future comparisons; justification of site design and management modifications due to the scientific validity and reliability of the data.

Management analysis

For this aspect of site rehabilitation, we used the traditional methods of park user surveys, personal interviews (park staff, public officials, community representatives), and public meetings. All of the data produced by these means were analyzed by computer and developed into charts or tables for reporting purposes (including filming).

Total man-hours consumed in this phase can be assess as follows: park user surveys (already accounted for), personal interviews (10 hours preparation, 100 hours administration to approximately 80 individuals), public meetings (2 meetings, 2 hours/meeting). Data analysis and preparation included: 40 hours for computer coding and analysis; 20 hours for report preparation. Therefore, approximately, 154 hours were used for conventional data gathering analysis and preparation.

Summary of Effort

Table 1 provides a summary of man-hours spent on both the traditional and non-conventional data collecting and preparation efforts used in this park rehabilitation 'study'.[1] From the summary, it appears that considerable costs are incurred with the incorporation of additional non-conventional techniques into the park study. Over 600 additional man-hours of work can be expected in a study using all of the data gathering techniques listed. This can amount to significant increases in project costs relating to salaries, travel, and other expenses.

However, if one examines the benefits derived from the expanded study effort--particularly in terms of permanent records on behavior, physical site conditions, and user groups--then the aded expense appears justified. Furthermore, after study costs in man-hours required to read and assimilate information from a technical report is considerably higher (on a person-by person basis) when compared to time required to observe a documentary film.[2] Therefore, in terms of information dissemination, we felt that the documentary film was more efficient in conveying information about the park sites. We further suspect, although all of our data collection efforts are not complete, that the film also conveyed the information more effectively for several reasons: 1) its shorter time span provided fewer opportunities for distraction; and 2) the impact of visual media appears to have greater power than the written word. From audience response after presenting the film versus presenting the technical report, we felt that the technical information contained therein was more easily conveyed, more completely presented, and less subject to misinterpretation to those reviewing the film. Further analysis of survey information and tapes taken of the audiences, and used to evaluate these two forms of information dissemination, will clarify these observations further.

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[1] It is important to note that these hours represent only on-site data collection, laboratory analysis, and data preparation of results. No travel or correspondence time is included in these figures.

[2] The technical report was 70 pages long, not including tables and figures; the documentary film, which included the same results as the technical report, took 22 minutes to air.

Table 1: A summary of man-hours used to complete various data gathering and information preparation tasks relating to a park rehabilitation project.

Methodology	Hours
Traditional Data Gathering Efforts:	
Management analysis (surveys, interviews, public meetings)	154 hours
Site Analysis	
(Physical inventories)	6 hours
(Basemap development)	12 hours
User Analysis	
(Visitor survey)	179 hours
Technical Report Preparation	60 hours
	411 hours
Non-conventional Data Gathering and Information Dissemination Efforts:	
Management analysis (film preparation)	20 hours
User Analysis	
(Traffic Counts and observation)	185 hours
(Personal observation)	273 hours
(Time-lapse photography)	46 hours
Site Analysis	
(Physical inventory filming and data preparation)	7 hours
(Basemap verification-transects)	10 hours
(Historical overview of change)	20 hours
Documentary film preparation	60 hours
	621 hours

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EVALUATION OF FUNCTIONAL BEHAVIOR OF SHORE STRUCTURES AND RELATED SHORELINE PROCESSES IN SUPPORT OF PLANNED 1985 BEACH NOURISHMENT AT ATLANTIC CITY

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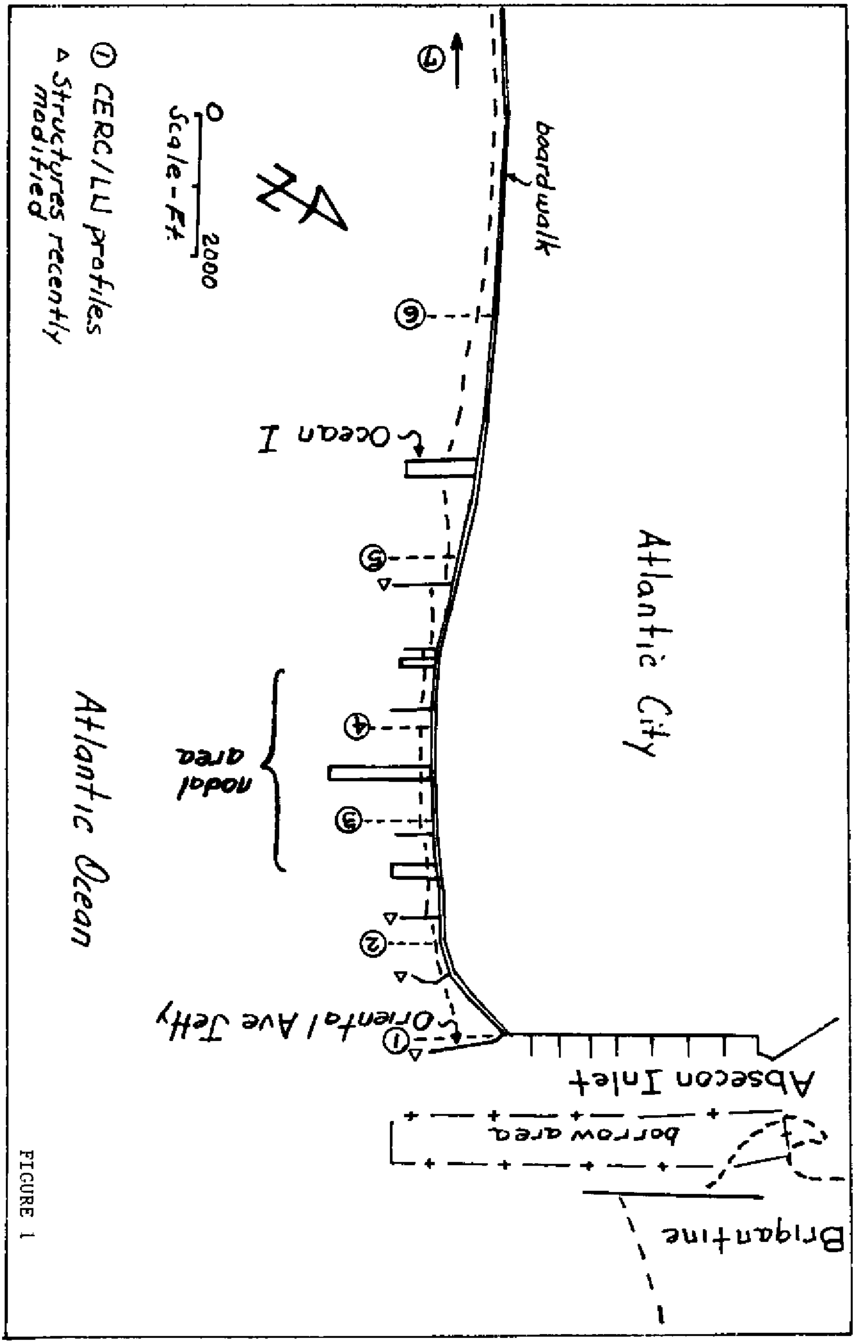
Introduction

Atlantic City occupies the northern half of Absecon Island, an 8.2 mile long barrier island having a northeast-southwest orientation, and is located about 40 miles north of the lower tip of Cape May. Features of interest are shown in Figure 1. Absecon Inlet is partially controlled by the Oriental Avenue jetty at Atlantic City and the Brigantine jetty. Since construction of the Brigantine jetty (1952-66) a fillet/shoal has formed inside the channel and connected to the jetty. In addition to the famed boardwalk there are four piers and several stone and wood groins. For more detail on the shoreline structures and their history see McCann (1981). FitzGerald (1981) discusses the recent geomorphic history of Absecon Inlet and the adjacent Atlantic City shoreline.

The beach at Atlantic City has been nourished in 1948, 1962, and 1970. A beach fill project is scheduled for 1985 with the sand to come from Absecon Inlet. Recently, the Oriental Avenue jetty and three of the groins have been modified. This paper reports on a study currently being conducted by the co-authors to evaluate the effect of these recent structure modifications on potential fill stability and to propose any desirable structure changes; to recommend the best source for beach fill; and to recommend the volume and location of fill placement in 1985. Some tentative recommendations are made - final, more detailed recommendations will be made in a later report.

Civil Works at Atlantic City

From February to May 1963, after the devastating March 1962 storm, 600,000 cubic yards of sand were taken from the inlet fillet and channel and placed on the beach over a distance of 3800 ft southwest of the Oriental Avenue jetty. In June and July 1970 [illegible],000 cubic yards of


Atlantic City
Atlantic Ocean
boardwalk
Ocean I
nodal area
Oriental Ave Jetty
Absecon Inlet
borrow area
Brigantine
N
0
2000
Scale-Ft.
① CERC/LU profiles
▵ Structures recently modified
1
2
3
4
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6
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FIGURE 1

sand were taken from the inlet fillet and channel and placed over 4800 ft of the beach southwest of the jetty. Each time, in the filled sections, the berm was widened to extend approximately 300 ft out from the boardwalk. Everts, et al. (1974), using profile data collected by the Coastal Engineering Research Center (see McCann, 1981) have documented the rapid removal of this fill. Most of the sand was carried southwest to naturally nourish beaches downdrift of the fill area. However, much of the sand moved offshore and some sand must have been carried over the Oriental Avenue jetty; both actions causing a net loss of beach sand above MSL at Atlantic City.

Using funding authorized under the 1977 New Jersey Beaches and Harbors Bond Act, four of the structures at Atlantic City were upgraded (see Figure 1). The crest elevation of the 1180 ft long Oriental Avenue jetty was raised from +7 ft MLW to +11 ft MLW. The next structure to the south, a dog-leg shaped groin, was extended 200 ft resulting in a C-shaped plan form. The third structure south of the inlet, a straight stone groin, was rebuilt at its outer end. And, an existing wooden groin just north of the Ocean I pier was extended 300 ft. The first three structures are north of the usual diverging drift nodal zone which is typically located between Garden Pier and Central Pier; while the other structure is to the south.

A 1983 New Jersey Shore Protection Bond Issue will provide funds, which should be available in 1985, for renourishment of the beach at Atlantic City. The State has requested permit authority to place 2.6 million cubic yards of sand on the beach to form a 300 ft wide berm from the Oriental Avenue jetty south to Ocean I pier. The berm is then to taper from 300 ft to 200 ft over the next 1500 ft of beach fill, and then to taper into the existing berm width of 200 ft within the next 1500 ft of beach. The sand would be taken from the proposed borrow area (Figure 1) in the inlet. The borrow section would stay at least 400 ft from the Brigantine jetty to preclude possible undermining of the structure, and sand would be dredged to depths of 25 ft below MLW.

Field Data Available

A wide variety of field data are available for evaluating conditions at Atlantic City. Sand size analyses are available for Absecon Island beaches (Ramsey and Galvin, 1977) as are wave gage data collected at the Steel Pier (Thompson, 1977) from 1962 to 1969 and wave hindcast data for 1956 to 1975 (Jensen, 1983). Historic charts of the inlet and Atlantic City shore dating back to the mid-1800's as well as recent hydrographic surveys of these areas made by the State of New Jersey and the Philadelphia District, Corps of Engineers are available. The State of New Jersey has also taken frequent air photographs of the study area since the 1962 storm. The usual wind and tide data are available. And, the Corps of Engineers (1974) has documented the history of civil works at the inlet and Atlantic City.

A most useful data set consists of periodic beach profiles, taken approximately monthly from November 1962 to April 1973, at seven locations (see Figure 1) by the Coastal Engineering Research Center (McCann, 1981). The profiles extend from the boardwalk out to wading depth. The survey period encompasses the 1963 and 1970 beach fills.

To supplement available field data, the authors will collect and analyze sand samples from the inlet within the proposed borrow area. We are also collecting beach profile data at the seven C.E.R.C. profile lines plus an additional line between profile 5 and Ocean I pier.

Behavior of 1970 Beach Fill

In 1970, 830,000 cubic yards of sand were dredged from the inlet near the fillet and pumped to the beach face. The dredged sand had a median diameter of about 0.3 mm. The native beach sand median diameter decreased from average values of 0.35 mm at CERC profile 2 to 0.23 mm at profile 6 (Ramsey and Galvin, 1977). Thus the fill and native sands were essentially the same. The berm crest elevation after the fill was at around +8 ft MSL and the berm width was about 300 ft at profiles 2, 3 and 4. The berm width at profile 1 was over 600 owing to the shoreline plan form and the jetty. The fill section extended from the jetty to just south of profile 4.

A good indication of the response of the fill placed at and above MSL is given by the beach profiles plotted in Figures 2 to 5. The profiles are for CERC profile lines 1 to 4. Survey dates are: May 18, 1970, just prior to fill placement; August 26, 1970, just after fill placement; April 12, 1971, one year after start of fill placement; April 10, 1972, two years after start of fill placement; and May 29, 1984, fourteen years after fill placement.

The most dramatic beach change can be demonstrated by comparing the May 70 and August 70 profiles to see the amount of fill placed and then the August 70 and April 71 profiles to see how much of that fill was lost during the first winter. Some of the fill placed on top of the berm at profile 1 was likely lost over the jetty which had a crest elevation of about +5 ft MSL prior to its upgrading, or lost by wave overtopping of the jetty which washed sand off the berm to the offshore area. Much of the sand lost from the beach face at profiles 1, 2 and 3 was undoubtedly permanently lost offshore but much of it also moved alongshore. At profile 4 the net change during the first winter was small, as sand was lost to offshore but gained from longshore transport of sand from the profiles further updrift (northeast).

Comparison of the April 71 and May 84 profiles at lines 1, 2 and 3 indicates that as much (or more) of the fill was lost from this section of beach during the first winter than was lost during the following thirteen years. Of course, much of this sand was transported south and provided a benefit to beaches further down Absecon Island.

Tentative Recommendations

With a fixed amount of funds for beach nourishment at Atlantic City over the next several years, it appears to be more desirable to place a volume of fill that is only a portion of the proposed 2.6 million cubic yards and to fill the beach at more frequent intervals (e.g. every two or three years) than approximately once per decade as has been done since the 1948 fill. In this way the total volume of fill placed on the beach should remain for a longer period of time. Beach users will experience more uniform beach conditions over a period of years which will have a more favorable impact in the long run. The nourishment program would essentially be a periodic sediment bypassing operation

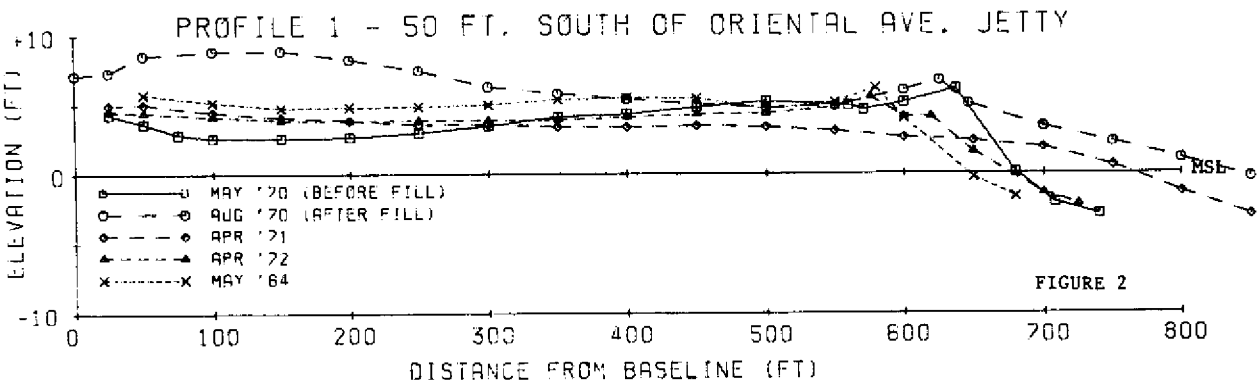

FIGURE 2

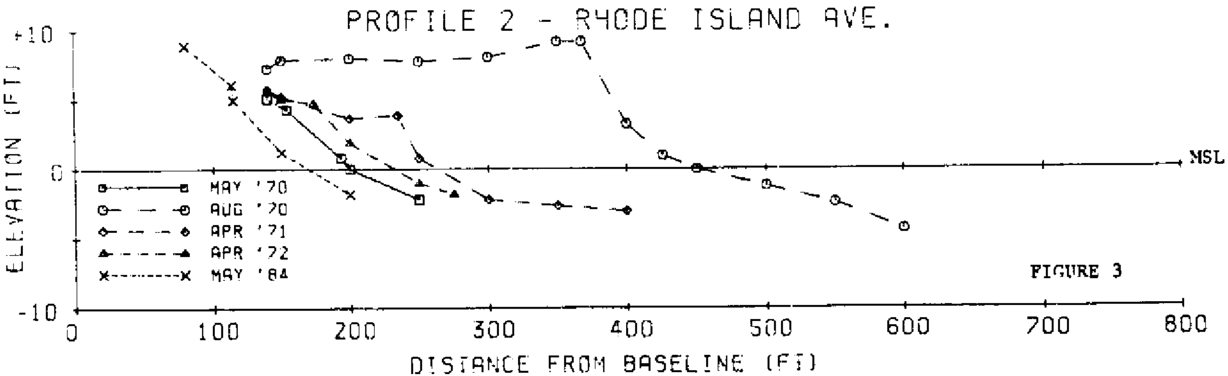

FIGURE 3

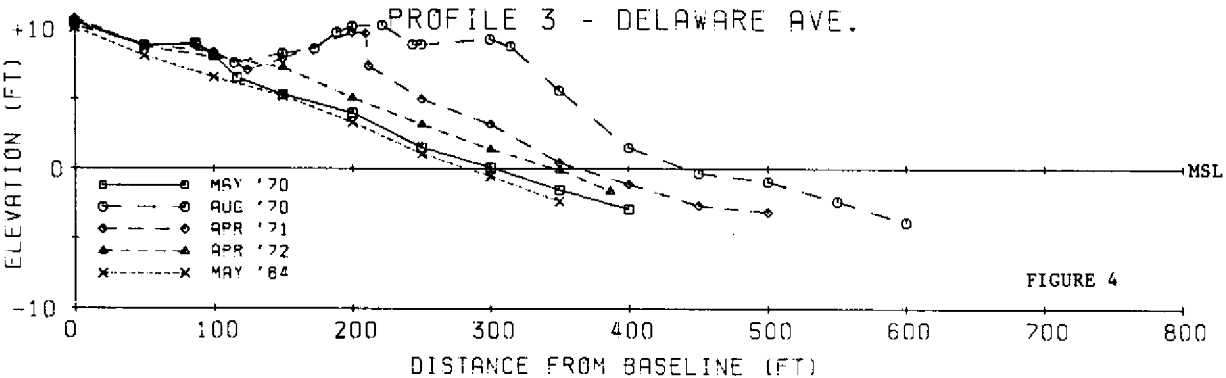

FIGURE 4

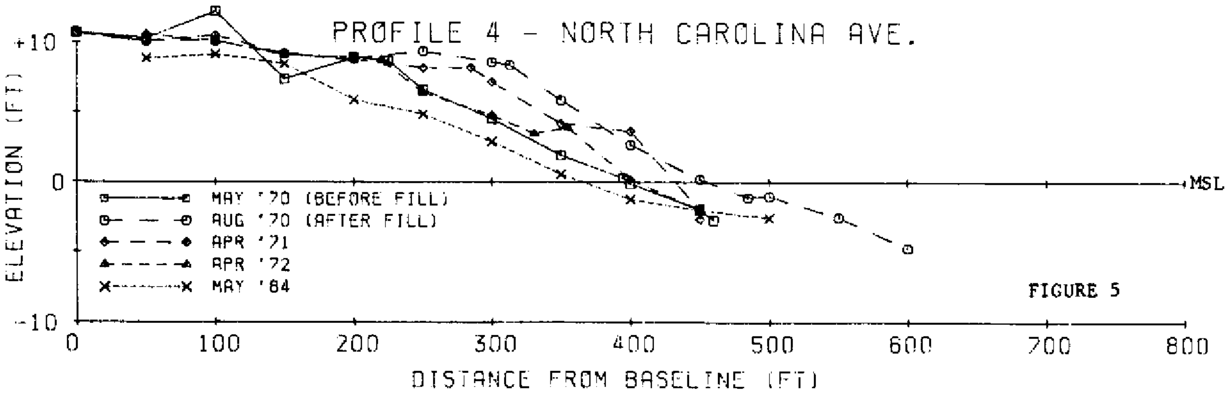

FIGURE 5

entailing removal of the southerly transport that deposits in Absecon Inlet and placement of it on Absecon Island for continued transport south with minimal loss offshore.

Based on the still incomplete analysis of sand samples from the inlet borrow area, it may prove worthwhile to take sand primarily from the inlet bar (at the outer ends of the jetties). This would be so if the sand from the bar is sufficiently coarser than the 0.3 mm median diameter sand previously used and thus have a greater retention time to wave action on the beach face. The growth of Atlantic City and the concomitant increase in vessel traffic into the inlet may require dredging of sand from the bar to maintain adequate navigation depths.

The raised Oriental Avenue jetty should have a positive effect in holdind sand on the adjacent beach. However, modification of some of the groins might have a salutary effect on the beaches. Groins limit longshore transport and thus will hold sand in the area of greatest need (in the more active recreational areas) where the shoreline bulges seaward creating the diverging nodal zone. However, this means that sand is less able to transport alongshore and is exposed for a longer time to storm attack and loss offshore. Each of the major structures is being evaluated to ascertain its most useful geometry in light of these considerations.

Conclusion

Limited funding is available to nourish eroded beaches at Atlantic City, so this study is being conducted to optimize the planned nourishment project. A thorough study of the history of previous fills and the impact of existing structures on local shore processes is being carried out. Recommendations will be made on the best location for borrow material, the volume and location of fill placement, and any shore structure modifications that should prove beneficial.

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SEGMENTED OFFSHORE BREAKWATERS: AN ALTERNATIVE FOR BEACH EROSION CONTROL

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Abstract

Segmented offshore breakwaters protect the shore by attenuating wave action and by promoting the deposition of drifting sediment in the lee of the structures, resulting in the development of a beach salient. The concept is not novel, but simply combines the wave attenuation of a natural shore-parallel sand bar or reef system with the wave diffraction effects of a nearshore island. Segmented breakwaters locally reduce incident wave energy and alter wave direction to create a "shadow zone" where longshore transported sediment or placed beachfill is retained. The philosophy and history behind the use of segmented breakwaters for beach erosion control, as well as advantages, disadvantages, and some design considerations are presented, together with example illustrations.

Segmented breakwaters have many advantages over other, more conventional forms of shore protection. Unlike groins, segmented breakwaters do not create a total barrier to littoral transport, nor do they promote offshore losses. Unlike revetments, bulkheads, and seawalls, they aid in the retention of a recreational beach. If the breakwater system is properly sited and designed, and beachfill is included as an item of construction, the impact to neighboring shores will be minimal. The main disadvantages of segmented offshore breakwaters are that they are more expensive to construct than land-based structures and that there are no standardized design criteria.

Although segmented breakwater systems have been previously implemented in Japan, Italy, Israel, Australia, and other countries, experience in the United States has been very limited. Breakwater systems have been constructed in areas such as Massachusetts, Ohio, Pennsylvania, and Virginia, and plans exist for incorporating their use at other sites. The design and application of the segmented breakwater concept at any particular site must be based on an evaluation of the local wave climate and littoral transport regime plus a review of the lessons learned from previously constructed projects. There are a few numerical and modeling procedures which may be applied to optimize a breakwater system plan, but the eventual design must heavily rely on engineering judgement and coastal experience.

Introduction

Although the concept of beach erosion control may be a subject of some technical controversy, there still is a real need for an effective way to preserve our recreational beach resources. Not only are opportunities for public access to beach front areas dwindling due to a boom in private development, but also overall beach area is gradually decreasing due to sea level rise and a loss of sediment sources. Shore erosion control is typically accomplished in one of three ways:

(1) By stopping shoreline recession through the use of onshore, shore-parallel structures such as seawalls or revetments.

(2) By adding new beach material through nourishment or sand by-passing operations.

(3) By reducing the rate of littoral transport.

The conventional structural approach used to reduce the local rate of longshore sediment transport is a groin or a groin system. Another mode available for influencing the longshore transport rate is the use of detached, or segmented, offshore breakwaters.

Segmented offshore breakwaters protect the shoreline by attenuating wave action and by promoting the deposition of drifting sediment in the lee of the structures. This results in the development of a beach salient. If the salient grows to the degree that it becomes connected to the structure, it is called a tombolo. The concept of segmented offshore breakwaters is not novel, but simply imitates the wave attenuating effect of a natural shore-parallel sand bar, reef, or nearshore island.

The Philosophy Behind Segmented Offshore Breakwaters

Segmented offshore breakwaters protect a zone of the beach from direct wave action and also cause a transformation of the incoming waves. The area directly behind the breakwater is sheltered as wave energy is dissipated on the structure. The wave energy in the gaps is also reduced as waves diffract, or bend, around the ends of each breakwater resulting in a lateral spread of wave energy and a net reduction in energy reaching the shore at any given point. The resultant effect, illustrated in Figure 1, is to drive sand into the sheltered area behind the breakwater where it is deposited.

Any structure whose function is to cause a local accretion of sand may cause damage to downdrift beaches if it traps material from the longshore system. The addition of beach fill to the project site is therefore highly recommended as a part of the project design. Enough sand should be placed to equal the amount which would be removed from the littoral system by the breakwater-induced beach. Designing a

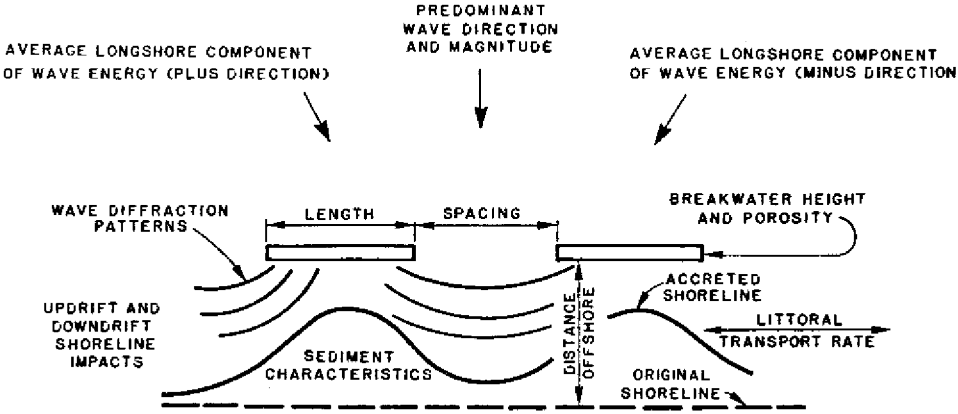

Figure 1. Segmented Offshore Breakwater Design Considerations.

breakwater system requires the prediction of the equilibrium beach and the amount of sand necessary to maintain that stable shoreline. By artificially adding an amount of fill equal to that required by the breakwater-induced salients, there will, in principle, be no net adverse impacts on the neighboring shores. This is a general statement which should be rigorously examined for any proposed project. Even with the initial placement of beach fill, variations in the wave climate at a site may make the range of erosion experienced by neighboring shores unacceptable.

The advantages of a segmented offshore breakwater system are best understood by comparison with the traditional sand accreting shoreline structure, the groin. Both methods of beach erosion control involve the use of a group of structures designed as a system. Groins are generally built perpendicular to shore. Segmented breakwaters are generally built parallel to the shore. Groins do not reduce the wave energy striking the shore. They are dependent on the presence of a trapped beach in order to provide some level of protection for the back beach. Breakwaters, however, do reduce a certain amount of the incident wave energy, depending on how much of the shore is fronted by the structure and the height of the structure. Groins tend to compartmentalize the shore and the longshore current system. Sediment moving alongshore is forced into deeper water in order to move around the structure ends, thereby increasing offshore losses. Frequently, the presence of a groin field will displace the nearshore bar system seaward. If breakwaters are designed properly, sediment will continue to move longshore behind the structures. The degree of reduction is a function of the design. Breakwaters have not been observed to increase offshore losses of sediment and, in fact, they may even reduce the offshore transport rate. Therefore, unlike groins, breakwaters do not promote offshore losses, do reduce the rate of longshore movement, and do allow regular longshore transport patterns to continue.

There are several disadvantages to the use of segmented breakwaters. They are expensive to construct, often involving the use of marine-based equipment. Also, available design experience and guidance is very limited. There is no handbook which contains rules and regulations for designing a segmented breakwater system. The parameters which control the complex interaction of sediments and structures are poorly understood, setting the stage for potential judgmental errors. But probably the greatest disadvantage is a perceived one. The lack of functioning examples in the United States reduces the public and even technical confidence level. People are reluctant to provide money for a project if they cannot walk down the beach and see a similar structure that is working.

History of Segmented Offshore Breakwaters

Although experience in the United States in the use of segmented offshore breakwater systems is limited, there have been a number of applications in other countries. In addition, single breakwater structures have a long history along the American shore. These structures may range from a low structure near the shoreline, which is frequently overtopped and functions as a perched beach, to a high, deepwater structure built in association with a harbor. Single breakwater structures exhibit different intents, designs, and construction. They have been built by individual property owners and by all levels of the Government.

A few major projects illustrate the typical types of single breakwater applications (U. S. Army Engineers, 1984). One of the first major single breakwater projects was the Venice, California, 183-m-long rubblemound breakwater, built in 1905. This structure was originally built to protect an amusement pier, and although the tombolo has been periodically eroded by storms, the beach has always returned. Other example projects where a single breakwater was built for erosion control are at Lincoln Park in Illinois and at Haleiwa Beach in Hawaii. Breakwaters built in the 1920's and 1930's at Santa Barbara and Santa Monica, California, were originally intended to create a harbor of refuge. However, both of these projects ended up trapping significant amounts of sediment, causing either a salient or a tombolo to form. An interesting multipurpose single breakwater was constructed in 1960 at Channel Islands, California. This structure overlaps the harbor entrance, helping to shield boats using the harbor from wave energy, and trapping material adjacent to the entrance, making it available for sand bypassing operations.

The concept of a system of segmented offshore breakwaters has been used extensively in other countries, creating a broad experience base (Lesnik, 1979). One of the best documented projects is the series of shallow water "artificial headlands" at Singapore. Other projects may be found in Italy, France, Israel, and Denmark, to name just a few. Segmented breakwaters have been used for almost 30 years in Japan. The Japanese consider the preservation of their coastal lands to be a national priority. The coast is heavily developed and periodically exposed to extreme wave events, such as typhoons and tsunamis. They have developed a construction and general configuration plan which has been installed and is successfully functioning at more than 20 different sites. Typically, Japanese breakwaters are built fairly close to shore, causing the almost complete development of a tombolo. These breakwaters have no core and are fairly porous. Full tombolo formation is inhibited by the large amount of wave energy which is transmitted through the breakwater. One of the first applications of a segmented breakwater system in the United States was the 1935 construction of five breakwaters at Winthrop Beach in Boston, Massachusetts. These breakwaters were constructed to protect the shore and a seawall. The approximately 3-m tide range at this site causes two distinctive shoreline responses. During high tide, the five breakwaters act as one unit, resulting in the formation of a single salient, while the low tide shore features five separate but smaller tombolos.

In 1977, three rubblemound breakwaters were constructed at Lakeview Park, Lake Erie, Lorain, Ohio. This project has been carefully monitored since construction, resulting in a unique data base which documents the shoreline response to a group of structures (Pope and Rowen, 1983). The project was designed to allow sediment transport to continue behind the breakwaters by placing them 120-150 meters off of the original shore. The placed beach fill has been remarkably stable, exhibiting a slight average annual accretion of approximately 2,300 cubic meters. A very stable shoreline has developed which undulates seasonally, due to changes in water levels and the wave climate, but repeats the same patterns.

Other, more recent segmented breakwater projects in the United States include: a shallow water beach erosion control project at Colonial Beach, Virginia, which includes a 3-breakwater and a 4-breakwater section; a 3-breakwater prototype test constructed at Presque Isle, Pennsylvania; a 4-breakwater, moderate water depth, "no fill" project at East Harbor, Ohio; and a 3-breakwater "with fill" project at Lakeshore Park, Ashtabula, Ohio. All of these projects except for the one at East Harbor are being monitored by the Corps of Engineers in an effort to improve the "state-of-the-design."

Design Considerations

In order to successfully design segmented offshore breakwaters, the wave climate and the sediment transport characteristics at the project site must be known. This includes understanding the average range of conditions and predicting the extreme conditions. Shoreline response is based on the magnitude and direction of the predominant incident waves (Figure 1). From this information, the designer attempts to predict the amount of wave diffraction around the structures, the degree of overtopping, and the net and gross sediment transport under average conditions. The designer also wants the project to function without detrimental impact to the backbeach features and neighboring shores during severe storms or periods of unusual quiescence. Seasonal and periodic variations in the coastal climate will cause the beach morphology to fluctuate. The salients will erode and accrete within an envelope which is controlled by normal cycles and the extreme conditions.

The challenge is to predict an average, stable shoreline configuration for various breakwater designs, then select the best one. The designer manipulates the breakwater length, gap width, alignments, height, wave transmission characteristics, and distance offshore until the desired shoreline can be predicted for the least amount of structure expense (Figure 1). An estimate of how much sediment the structures would ordinarily trap is then made allowing original fill and maintenance fill quantities to be programmed.

Design tools currently available include the use of a simple diffraction analysis. The average wave climate from different directions is evaluated and a diffraction analysis performed. The different diffraction patterns are then compared and an average shoreline predicted. Another tool which holds promise for making qualitative predictions is the use of a movable bed, physical model. Each of these tools has been verified by comparison with the field data collected from the Lakeview Park project and found to accurately reproduce the prototype shoreline response of that project. Of course, in the case of a major project, the construction of a preliminary field test structure may be warranted. By constructing and monitoring a small-scale prototype structure at the project site, invaluable data can be collected and used to fine tune the full project design. The three breakwaters at Presque Isle were constructed with such a purpose in mind. The data collected from these structures is being used to assist in the development of a project design involving the protection of 5 miles of eroding shore.

A new tool, which is just becoming available for predicting sediment response to coastal structures, is the numerical model. There are a number of numerical models available, but only limited field verification tests have been made. Numerical models bring the design wave condition to the structure, then diffract, refract, and shoal the waves to breaking. Some models even allow for wave transmission at the structure. From this combination of effects, the incoming wave train is transformed as it would be in nature and a resultant shoreline is predicted.

Summary

The concept of segmented offshore breakwaters has theoretical promise. Such breakwaters have functioned successfully at a number of sites. Segmented breakwaters should not be indiscriminately applied to all projects and sites. Until more projects have been built and monitored at a variety of sites we will not know if they are suitable, for example, for use along shores with a high tidal range or for localized protection along a shore with a large littoral cell. Design mistakes will be made, but if we understand the design limitations and are sensitive to the demands of the environment we will have a means of controlling local beach erosion which works with the processes of the shore rather then against them.

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CURRENT AND SHORELINE EFFECTS OF SHORE PERPENDICULAR STRUCTURES

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THE PROBLEM

Groins and jetties are shore perpendicular structures made of wood, steel, or stone, and are used throughout the Atlantic and Gulf Coasts of the United States as shoreline protection and navigation structures. The effectiveness of groins in protecting and stabilizing a shoreline, however, is disputed. While littoral material has been shown to accumulate on the updrift side of the structure, the shoreline on the downdrift side has been observed to erode (Figure 1). Unfortunately, the mechanism causing the observed condition is poorly understood. Jetties likewise interrupt littoral drift, and thus create situations similar to that experienced with groins. The objective of this paper is to highlight past laboratory and field investigations, apply these observations to existing problem areas, and develop an understanding of the information needed to identify the responsible physical processes and adequately mitigate the observed and expected adverse effects.

LABORATORY STUDIES

Investigation in a controlled setting offers the opportunity to quantitatively observe coastal processes. Both wave tank models and numerical models have been used to examine wave and tidal currents around groins and jetties. A recent investigation involving weir jetty performance by Seaberg (1983) provides an excellent example of wave induced current circulation in varying conditions. The downdrift circulation patterns were characterized by large eddys. These eddys were most accentuated during maximum ebb flow and 10 second period waves approaching from the updrift side at an angle of 30°. Unfortunately, the limited side of physical models does not allow for the observation of large scale circulation patterns far downdrift of such structures.

Computer generated numerical models have also been used to predict wave and current patterns on beaches and nearshore structures. Most models are based on the concept of radiation stress, and yield results in the form of force vectors represented as current velocities. The generic case of a shore connected breakwater is probably best represented by the work of Liu and Mie, 1975. Their results show distinct up- and down-drift circulation patterns. The updrift pattern is characterized by several elliptical, alternating flows, and the downdrift pattern exhibits one large eddy parallel to the shoreline (Figure 2). A similar downdrift pattern was found by Bettes, et al., (1981) in their investigation of a large port protruding into the surf zone. Other computer models which predict shoreline position in the lee of such structure (e.g. Perlin and Dean, 1983) show a log spiral shoreline, presumably formed by the observed circulation cell. Thus far, computer models have lacked the storage capacity to analyze entire shorelines and associated structures. However, it is hoped that the recent advances in microprocessing will be matched by a better understanding of the controlling physical processes, and larger boundary areas will be developed.

FIELD INVESTIGATIONS

Field investigations are much more qualitative than laboratory models because of the difficulty in obtaining real time data measurements in the complex physical environment. Therefore, most data is descriptive; for example, aerial photos. However, some float measurements have been recorded in the lee of groins in North Carolina (see Figure 3). These current tracks show two basic trends. One trend extends into the surf zone (near the collapsed section of the groin) and meanders offshore, downdrift of the groin. The other trend approximates a large spiral eddy forming landward of the surf zone. As in the wave tank studies, these measurements do not extend far enough downdrift of the structure to identify additional spiraling eddys.

Where float measurements are restrictive, aerial photographs allow large areas to be observed simultaneously. However, they are not quantitative. Therefore, current patterns must be deduced from shoreline characteristics. A good example of the downdrift shoreline is presented in Figure 4. Note that an obvious log spiral beach has formed immediately downdrift of the last groin. As one looks farther down the shoreline, more subtle crescentric beach forms appear periodically. It is inferred that the shoreline forms in response to the wave induced currents. Thus, the observed beach forms probably evolved in response to a specific wave event. A spiralling eddy shearing off the last groin could be responsible for the observed shoreline pattern (see Figure 5).

DISCUSSION

Until now, we have considered a situation with a uni-directional wave. In the natural environment the mixed wave spectra creates many variations in the resultant circulation patterns. Visual observation of downdrift circulation cells has revealed that a dominant wave direction less than 45° produce much larger downdrift beach forms, while angles greater than 45° (but less than 90°) produce smaller more numerous cells. One way to verify this is by recording the log spiral pattern or signatures of the downdrift shoreline resulting from different wave events. Of course, during complete littoral drift reversals (i.e. reversal of wave direction) the formerly downdrift area becomes the updrift area. For simplicity, we assume here the updrift circulation pattern changes to the downdrift pattern as the littoral drift reverses. Notably, incidence angles less than 45° creates larger cells in the downdrift area, which decrease along the beach axis length as the wave incidence angle approaches 90°. Figure 6 is a graphic description of the probable patterns. Furthermore, one would expect the dmoinant wave spectra to produce a recognizable signature on both the updrift and downdrift beaches, which is only temporarily modified by individual wave events.

The benefits of understanding these circulation patterns are:

(1) To predict the rate of change in shorelines (updrift and downdrift)(see Everts, 1983).

(2) To mitigate the potentially adverse effects of these structures on the beaches.

In order to apply this model to specific problem areas, a data base for the site must be prepared. The simplest method of doing this is through combining remotely sensed and field collected data. In situations where historical data is available this method is less expensive; however, it is preferable to have at least one, if not several, semi-monocromatic wave events to record current circulation patterns and resultant shoreline configurations. Typically, the following data is needed:

(1) Metric Aerial Photograph: Photos should be acquired before, during (if possible), and after a specific storm event.

(2) Wave Data: Incidence angle, wave height, wave length, and wave period.

(3) Circulation Data: Rhodamine dye or, even better, artificial jellyfish (see Chapman and Smith, 1979) may be introduced at the head of the terminal structure and their progress monitored by short term hand held or metric photography.

(4) Historical Beach Profiles and Aerial Photographs: Whenever possible, these two variables should be tabulated and correlated to show dominant long term trends.

The deduction of the up- and down-drift circulation patterns should lead the investigator to the sand movement patterns as well. It is through the knowledge of how the system works that one can hope to manipulate it into the desired result. The basic options available are (1) structure removal, (2) covering the structure with sand, (3) modifying the structure, or (4) compensating for the effects through another action (e.g. sediment bypass). There are many variations to each option, and the body of knowledge gained through scientific investigation should lead the investigator to the best alternative.

CONCLUSION

The problem of littoral drift interruption by groins and jetties is the legacy of many shore stabilization and navigation projects. Laboratory investigation involving wave tank models and computer generated models are in close agreement, but are limited by constricting boundary conditions. Field investigations including float studies and aerial photographys have greatly increased the boundary areas and compare remarkably well with laboratory data.

A model to deduce current circulation patterns around shore perpendicular structures is proposed. This model predicts patterns based on varying angles of wave incidence, and a method to verify the model with field investigations is also presented. The data gathered through individual site examinations may then be used to select appropriate mitigation action.

The alternatives for mitigation include the following:

(1) Structure removal,
(2) Covering the structure with sand,
(3) Modify the structures, or
(4) Compensate for the adverse effects through another action (e.g. sediment bypass).

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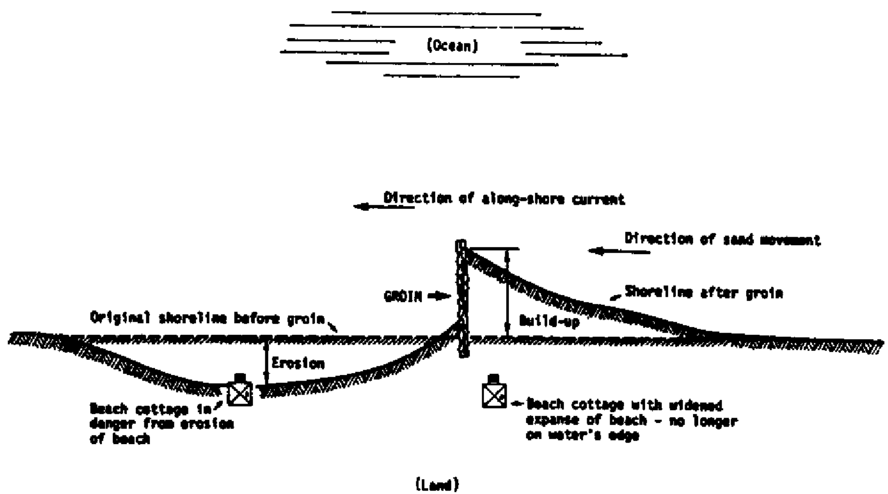


Figure 1: Effect of a groin on the shoreline. (From Pilkey, Pilkey, and Turner, 1975, How to live with an Island, North Carolina Department of Natural and Economic Resources,)

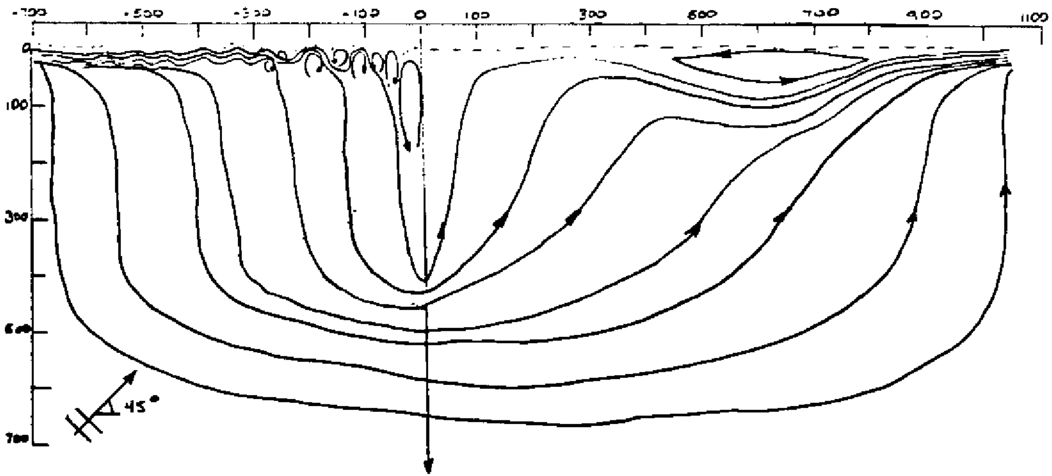
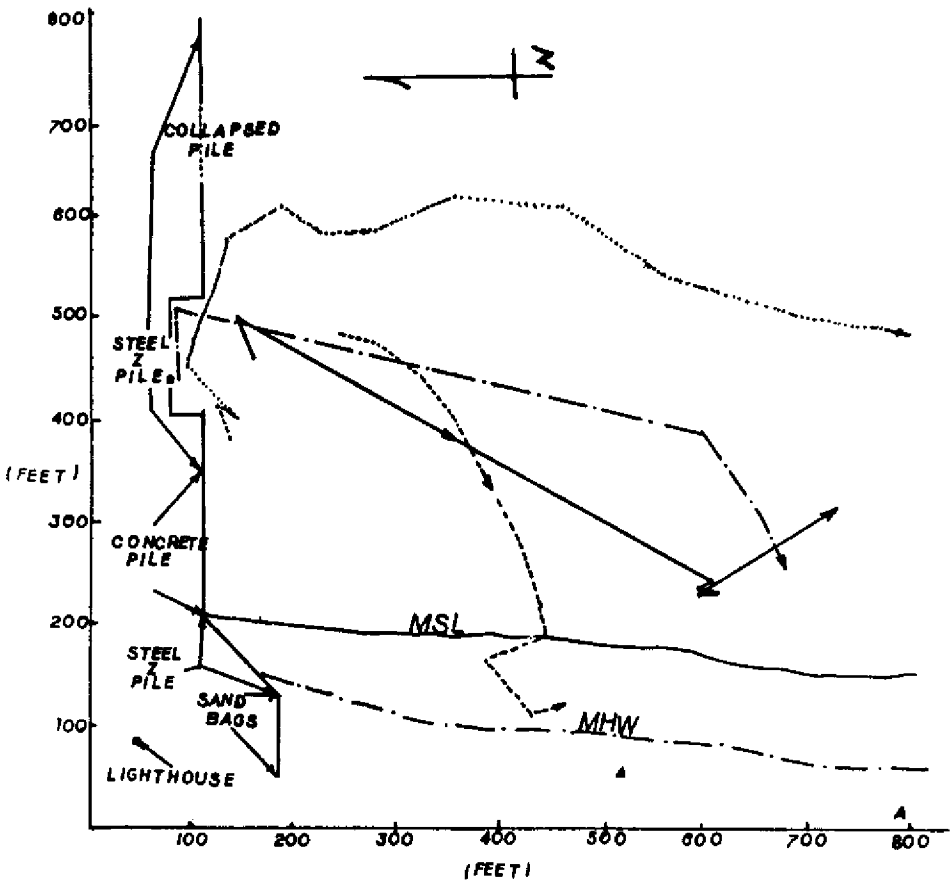


Figure 2: Computer generated current velocity vectors due to incident waves (45° angle). Distance is in meters. From Liu and Mei, 1974.

Figure 3: Surface current tracks from drifter buoys. Measurements made at the Cape Hatteras Lighthouse groin, North Carolina on 10 May 1981.



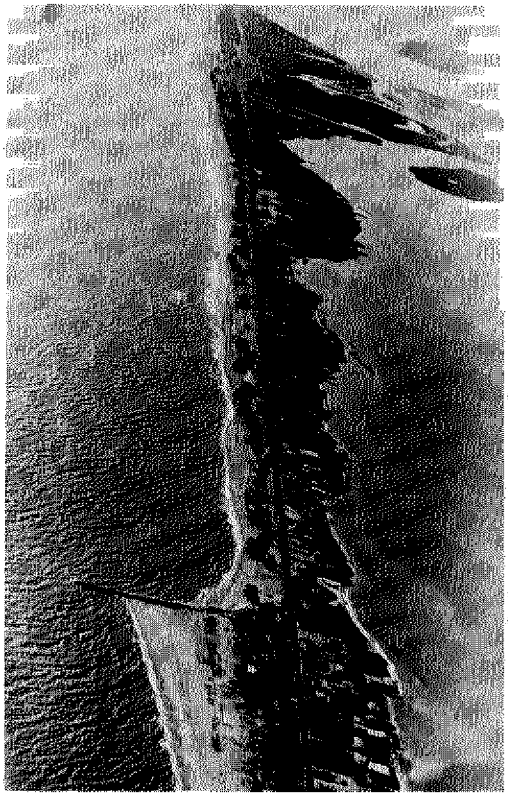


Figure 4: Westhampton Beach, NY groin field looking to the west (August 1984). Note the periodicity of the shoreline to the west of the last groin. Dominant littoral drift is from east to west in this region (300,000 cubic yards per year).

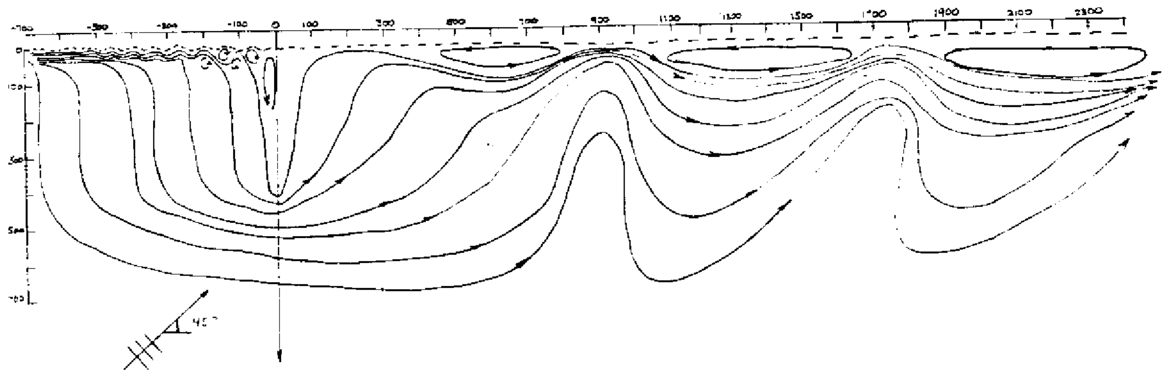
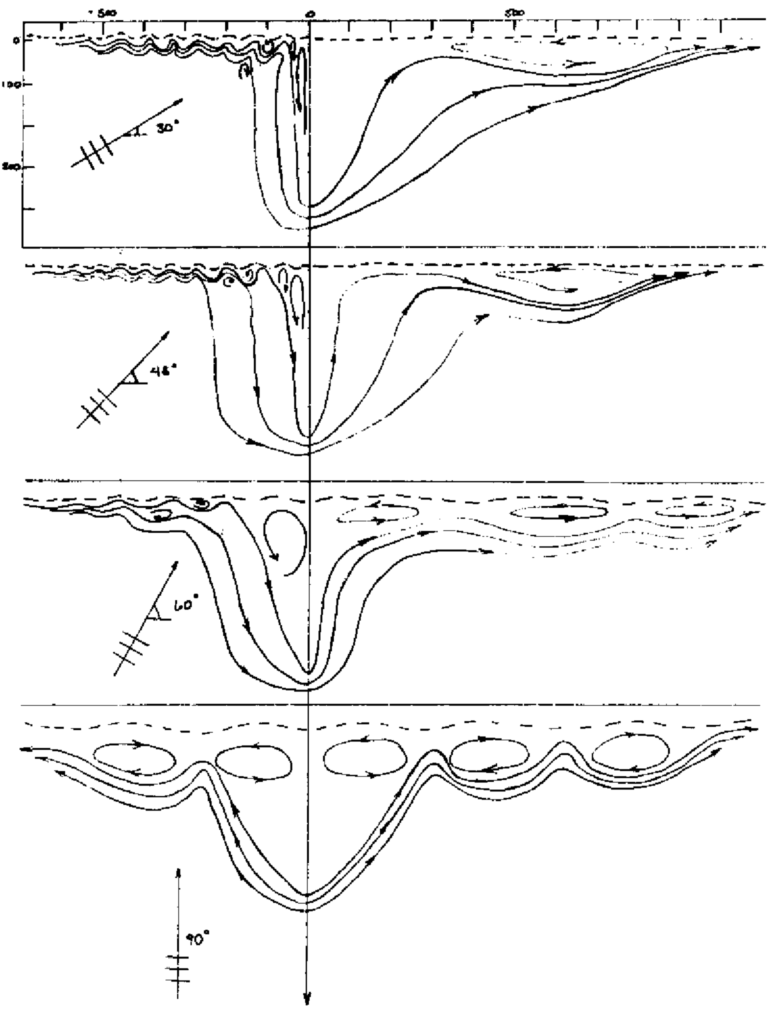


Figure 5: Proposed wave induced current circulation with increased boundry conditions. This is a combination of computer generated models and field investigations. Adapted from Liu and Mei, 1974.

Figure 6: Proposed changes in wave induced current circulation patterns with varying wave incidence angles. Adapted from Liu and Mei, 1974.



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LOS ANGELES HARBOR KELP TRANSPLANT PROJECT

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Abstract

In 1977, the Los Angeles Harbor Department planned and implemented a kelp transplant project to enhance wildlife resources in the Harbor in order to offset potential losses to marine habitat from two Harbor Department projects. Kelp restoration techniques developed by the California Institute of Technology and the California Department of Fish and Game were applied to transplant the giant kelp, Macrocystis spp., to Los Angeles Harbor.

The first step in the transplant operation was to deploy an artificial substrate for the attachment of plants along two areas of Los Angeles Harbor's breakwater. Phase I of the transplant operation involved collecting several hundred adult kelp plants from nearby Abalone Cove on the Palos Verdes Peninsula and transplanting them to the previously deployed artificial substrate. A second phase of the project involved collecting, transporting, and transplanting several hundred kelp plants from Bahia Tortugas, Baja California to Los Angeles Harbor. The third phase of the project involved transplanting kelp sporophytes reared in the laboratory by the University of Southern California to the transplant sites.

By August of 1978, kelp was successfully established and growing on the San Pedro breakwater. At the present time, an essentially continuous kelp bed approximately 9,000 feet (2700 m) in length has developed along the inside of the inner San Pedro breakwater and kelp is spreading to other nearby shorelines.

As a result of the project, fish and invertebrates have emigrated to this habitat, increasing the abundance and diversity of marine life in Los Angeles Harbor.

Introduction

Early in 1977, the Los Angeles Harbor Department began planning an experimental marine habitat enhancement project in order to develop wildlife resources in the Harbor to offset potential losses to marine habitat from two Harbor Department projects. These projects were the filling of a 10-acre slip known as Berth 232, along the Harbor's main channel, to create backland for a new container terminal; and the construction of a 600 foot (182m) wharf at Berth 206 in connection with an expansion of an existing container terminal. The concept selected by Los Angeles Harbor to offset potential habitat losses was to create, by transplant techniques, a giant kelp (*Macrocystis* spp.) bed within Los Angeles Harbor. This concept was proposed to the U.S. Army Corps of Engineers and the California Coastal Commission and subsequently incorporated as permit conditions for these projects.

Groupings of large marine plants or "seaweeds" are known as kelp beds. These kelp beds in coastal areas of Southern California and Northern Mexico are usually comprised of the giant kelp, *Macrocystis* spp. The importance and utilization of kelp beds is well documented (North, 1968). *Macrocystis* is the fastest growing plant known, sometimes increasing in length more than 18 inches (45.7 cm) per day (Haaker, 1975). Kelp beds provide habitats for many of California's shellfish, fin fish and mammals. At the time the experimental transplant project was conceived, there was no natural kelp bed existing in Los Angeles Harbor. Although historical records on the abundance and distribution of marine plants are sketchy, a U.S. Coast and Geodetic Survey map of the Port dated 1908 indicates that large seaweed beds were present both inside the breakwater and offshore from Los Angeles Harbor. Historically, natural and man-made changes have adversely affected the kelp bed environment. Large kelp beds that once existed along the Palos Verdes Peninsula of Los Angeles County, which includes the area of Los Angeles Harbor, had disappeared by the late 1950's. Since no giant kelp was growing in the Harbor in 1977, the establishment of a kelp bed would benefit the Harbor's ecosystem and provide food and shelter for fishes and invertebrates. Kelp restoration efforts have been undertaken along the Palos Verdes Peninsula in recent years by researchers from the California Institute of Technology and the California Department of Fish and Game (Wilson, 1978). It was the application of these techniques that the Harbor's Environmental staff intended to apply within Los Angeles Harbor to establish the kelp bed.

Discussion

The first step in conducting the transplant operation was to deploy an artificial substrate along the breakwater of Los Angeles Harbor for attaching the plants. Two sites were selected for initial transplant efforts, one at the bend of the San Pedro breakwater and a second was located several hundred meters east of the Harbor entrance (Figure 1). At each transplant site, eighteen 40-foot (12 m) lengths of anchor chain with 50-pound (22 kg) steel blocks welded at each end were placed perpendicular to the breakwater (Figure 2). Floats secured to a four-foot (1.2 m) long, one quarter inch (.6 cm) diameter nylon line were tied at four-foot (1.2 m) intervals along the anchor chain to provide 10 attachment sites per chain. Sites were established for 180 plants in a 50-foot (15 m) by 200-foot (61 m) area at each transplant location. The floats provided an attachment site for the kelp plants,

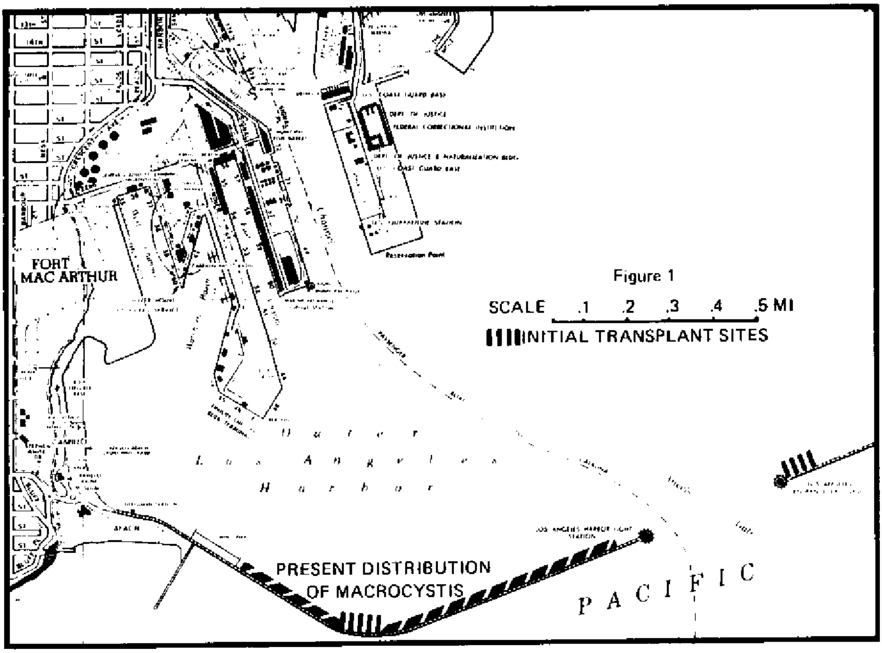

Figure 1

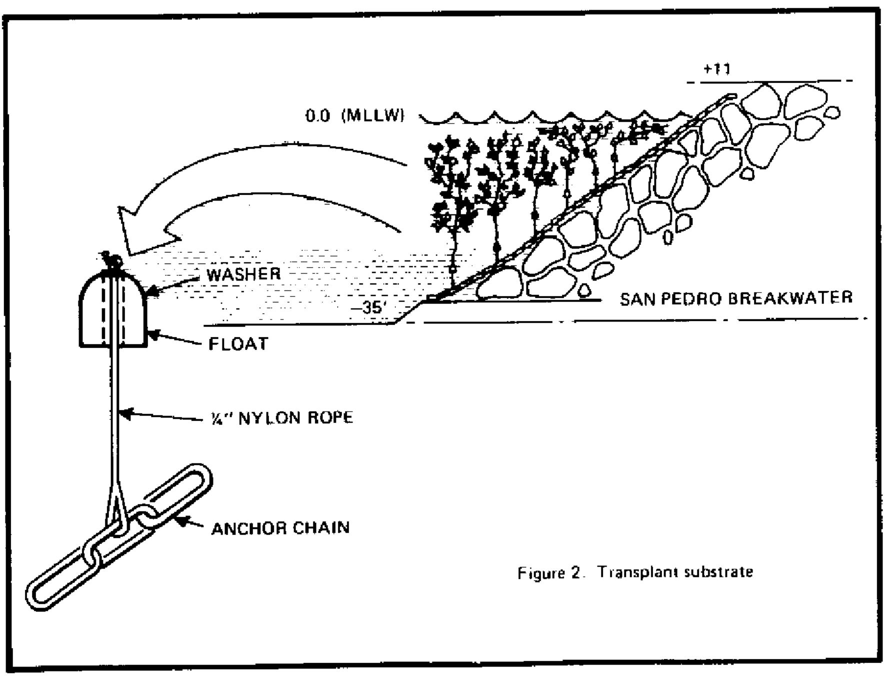

Figure 2. Transplant substrate

and the 4 foot (1.2 m) nylon line created a barrier against sea urchin grazing. The goal of the transplant project was to provide attachment sites for enough plants to act as "seed stock" in order to enable the kelp bed to expand through the natural reproductive process of Macrocystis.

Transplant activity at the two sites is shown in Table 1. In the first phase of transplanting, local kelp was obtained from Abalone Cove on the Palos Verdes Peninsula where the transplant efforts of California Institute of Technology and Department of Fish and Game (1967-1976) had resulted in a dramatic restoration of previously existing kelp beds. Plants from six to twelve feet (1.8 - 3.6 m) in length were selected and an attempt made to find plants insecurely attached which would probably break loose and be lost during local winter storms. These plants were brought aboard the transplant vessel where nylon line was threaded through the holdfasts. The plants were then bagged and placed in water-filled bait tanks or containers by University of Southern California staff, the Harbor Department's contractor for this portion of the transplant operation (H.E.P., 1978). Transplanting was accomplished by tying the holdfasts of plants to the floats attached to the chain substrate.

TABLE 1
TRANSPLANT ACTIVITY

	Date	Number of Plants: Federal Breakwater	Number of Plants: San Pedro Breakwater
Primary Transplants			
Abalone Cove Plants	5/23-6/3/77	118	121
Mexican Plants by Truck	6/15/77	53	75
Mexican Plants by Boat	6/16/77	51	
	Sub Total	222	196
Supplemental Transplants			
Abalone Cove Plants	7/27/77	43	13
Abalone Cove Plants	10/28/77		43
Abalone Cove Plants	3/29/78		91
Abalone Cove Plants	6/1/78		35
Abalone Cove Plants	3/29/79		43
20 Plants Cultured by Dr. Neushul (UCSB)	4/12/79		20
Abalone Cove Plants	3/12/80		37
	Total	265	478
Dispersal of Embryo and Juvenile Plants	7/77 - 5/78	14,000 ft. of seeded twine	

Phase II of the project involved transplanting several hundred kelp plants from Bahia Tortugas, Baja California. Bahia Tortugas offered large quantities of a variety of kelp adapted to warmer waters. Kelp can be adversely affected by water temperature increases and since harbor waters are usually warmer than adjacent coastal waters the Baja kelp was selected. Seven men, including five from the Los Angeles Harbor Department, and one each from the California Department of Fish and Game and the U.S. Army Corps of Engineers, flew in two small planes to Bahia Tortugas, 400 miles (643 km) south of the border on the Baja Peninsula's Pacific side. There, with the cooperation of Alfonso Solares of the Mexican Fish Commission and other Mexican officials, the team located and bagged the kelp. Most of the plants, some over 30 feet (9 m) in length, were individually wrapped in burlap and plastic bags with sea water and oxygen added and then boxed in styrofoam cases for protection and temperature insulation of the fragile kelp. After delivery by plane to the United States-Mexican border, this kelp was trucked to Los Angeles Harbor and transplanted in the same manner as the local Abalone Cove kelp. Additional plants were returned to Los Angeles Harbor in the bait tanks of the fishing vessel "Marty B" on its return voyage to the Port from commercial fishing in southern waters.

Results

By August 1978, kelp was successfully established and flourishing on the San Pedro breakwater. The winter storms of 1977-1978, combined with intense grazing by fish resulted in the near complete destruction of the plants at the site east of the Harbor entrance. This resulted in an eventual decision to abandon that area and concentrate all future effort at the San Pedro breakwater site. Supplemental transplants of approximately 180 plants were required to replace lost or damaged plants at the San Pedro breakwater site between the summer of '77 and the summer of '78. During that same period, dispersal of sporophyte and juvenile plants, cultured by the University of Southern California, were dispersed at, and adjacent to the transplant sites (H.E.P., 1978). In 1979, 63 plants were transplanted from Abalone Cove and 20 plants cultured by Dr. Mike Neushal of the University of California at Santa Barbara were also placed in the transplant area.

By 1979, there were sufficient numbers of plants growing in the area from the natural reproduction of the adults to thin out the main transplant areas and place plants in other areas of the breakwater. These plants have continued to grow and reproduce along the breakwater. At the present time, an essentially continuous kelp bed has developed along an approximately 9,000 foot (2700 m) portion of the inner San Pedro breakwater. Periodic maintenance of the kelp bed has included removal of sea urchins which feed on small kelp plants.

Since 1980, a distinct seasonal cycle in the growth and development of the kelp bed has become evident. Maximum density of plants is normally reached between June and October. From October to March, there is a general decline in the numbers and condition of plants. Recruitment of juveniles begins in April, and by June the kelp areas are generally too dense to swim through.

Although quantitative data on the kelp bed is limited, some recent information has been collected by (Maner, 1983). Between October and December of 1982, Maner surveyed 3 transects on the San Pedro breakwater to a depth of 30 feet in order to determine the condition of the kelp plants and determine their growth characteristics (Table 2). General trends evident from these data are higher densities ($4/m^2$) of plants at shallow depths (-6 feet) and larger, more robust plants found in lower densities ($1/m^2$) at deeper depths (-12 feet/-18 feet).

Table 2. San Pedro Breakwater *Macrocystis* Characteristics (Winter 1982)

Depth	Total Individuals Examined From Three Transects	$\bar{X}$ Marcroystis Densities (M^2)	$\bar{X}$ Biomass (Wet Weight) lbs	$\bar{X}$ Number fronds/ plant (blades/ frond)	$\bar{X}$ length of plants (ft)
-6' (1.8m)	12	4	1.2 (.54 kg)	18.3 (14.4)	10 (3m)
-12' (3.6m)	3	1	10.2 (4.6 kg)	23 (21.4)	15 (4.5m)
-18' (5.4m)	3	1	10.7 (4.8 kg)	21.6 (21.3)	12 (3.6m)

From: Maner, 1983.

As a result of this project, fish and invertebrates that have been recruited to this habitat which have increased the opportunity for recreational fishing off the San Pedro breakwater. In addition, there are many species of marine life, such as those inhabiting kelp holdfasts, now living in this kelp bed which, at least in recent history, were previously unknown from Los Angeles Harbor. These organisms contribute to the diversity of life in the Harbor and have a very positive effect on the health of Los Angeles Harbor's ecosystem. As a result of careful planning, international cooperation, and intergovernmental teamwork, the project goal of establishing a kelp bed in Los Angeles Harbor has been achieved. At the present time, there is reproducing, self-sustaining population of *Macrocystis* that appears to be well adapted to Harbor waters.

As indicated previously, the kelp bed project was undertaken as a permit condition mitigation for port development. The permit condition called for creating a 3½ acre kelp bed, recognizing that the effort was experimental. If the kelp project was not successful, permit conditions called for the creation of a 3½-acre salt marsh.

The Army Corps of Engineers, after consulting with federal and state wildlife resource agencies, declared the kelp transplant project unsuccessful in 1979 because the required 3½ acres were not present. The Harbor Department has now constructed a 3½-acre salt marsh to satisfy the required permit conditions for the port developments.

At this time, the Port would like to use the habitat value created for the kelp bed project as a "credit" to offset losses from planned future developments. Our present efforts are directed at establishing a value of the area enhanced by kelp in relation to harbor habitat likely to be impacted.

Studies can be implemented to measure primary production, fish abundance, diversity, or other characteristics of the area but the difficulty arises in translating these objective measurable data into subjective value.

Suggestions would be welcomed by the authors as to possible approaches for quantifying habitat value of the kelp bed project.

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THE INTEGRATION OF ECOLOGICAL FACTORS AFFECTING MARINE TURTLE NESTING BEACH MANAGEMENT

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Introduction

Human influence on a suite of ecological factors is currently affecting marine turtles globally. All turtle species lay eggs on land which requires them to leave the water to complete this part of their life history. By most reasonable estimates, they have been performing this task for more than 200 million years. One would think that after all that time they would have worked out most of the problems. So why are they all endangered?

There is no question that they have become quite accomplished at this phase of their life, however while they were perfecting and genetically locking in their migratory and nesting-related behaviors, the world was changing. For millions of years it was a tremendously successful strategy to live in the seas and coastal waters, swim to remote beaches where predator-related pressures were at a minimum, and lay eggs. But since the period during which sea turtle behavior slowly evolved, conditions have changed considerably. Most of the ancient crustaceans, amphibians, and reptiles became extinct and birds and mammals evolved. To survive the advent of mammalian predators, modern avifauna, and the myriad of other influences, speaking from an evolutionary perspective, marine turtles must have been doing something right, especially when one considers the fact that very few other vertebrate species, genera, or even families have withstood the past 200 million years relatively unchanged.

Moving to historic times, we know that as recently as 100 years ago there were very large populations of sea turtles in the tropical and semi-tropical waters all around the world. We also know that during a certain time of the year, depending on the location, thousands of turtles congregated off specific shores where they mated, and then females crawled on shore and laid their eggs. Whalers documented these crawls. They had beaches which they visited occasionally to pick up their next few months of fresh turtle meat. On the whaling vessels large turtles could live a year upside down, protected from the sun, without food or water. In time, factories were established at nesting beaches. Thousands of turtles and eggs were sent to market. The supply seemed inexhaustible. But all that changed. Now populations of all species of sea turtles are critically low, and we are trying to save them.

Over 99% of our research focuses on nesting behavior, incubation, and hatchling emergence, even though this comprises less than 1% of the turtle's life history. This may be understandable considering the extended migrations, often more than 2,000 km, to remote feeding areas and nesting beaches. As a result, we are currently directing our energies toward nesting-beach management because it appears that this is where our efforts will be most productive. This part of sea turtle behavior is concentrated in time and space. This is where the turtles are the most vulnerable, and this is when management policies can be the most cost effective.

Lighting, Groins, and Development

A site was studied along an 18 km stretch of developed beach between Delray Beach and Fort Lauderdale, Florida, where it was found that nesting females did not avoid highly developed, intensely lighted beaches in favor of darker, undeveloped beaches. But rock groins, circular mounds of rock used to retard erosion, positioned 20-30 m apart in the intertidal zone at Deerfield Beach may have deterred nesting. False crawls, where turtles come out apparently to lay eggs but turn around and return to the water, were very scarce at this beach, even though the wide spacing of groins permitted easy access to the turtles (Mann, 1978). It could be that the groins discouraged nesting turtles because natural selection has favored turtles that do not nest near rocky environments which harbor fish and other potential predators which would take a significant toll of hatchlings when they make their way out to sea. To my knowledge, no one has mapped rocks and reefs and sandy bottoms where turtles lay their eggs and where they do not lay their eggs to see if there is a correlation. Likewise, no one has studied the effect other erosion-related structures may have on nesting behavior.

Moving light sources such as vehicular traffic may have deterred nesting. However, the major effect of artificial lights appears to be related to the disorientation of hatchlings. Where nearby artificial light sources were directly visible from the nest, the majority of hatchlings usually headed inland rather than toward the water. Interestingly, it has been found that the sea-finding behavior of hatchling Green turtles (Chelonia mydas) is not significantly influenced by flashing lights (Mrosovsky, 1978). It has also been learned that when artificial light sources from buildings and other structures were not visible from the nests, hatchlings often oriented correctly, even though diffuse light over the landward horizon was more intense than that over the sea.

When the moon was the brightest and visible for most of the night, emerging hatchlings would sometimes orient correctly from beaches where disorientation usually occurred on moonless nights. This may be due to the moon's reflection on the water. At Cape Lookout National Seashore it has been documented that emerging hatchlings within sight of the lighthouse head toward it, rather than out to sea (Garber, 1984a).

Disoriented hatchlings appear to have a low survival rate compared to those hatchlings which make their way straight to the water without interruptions. One study found the percentage of disoriented hatchlings killed by cars, crabs, or just drying out ranged as high as 96%, depending on the particular situation (Mann, 1978).

The presence or absence of barriers such as sea walls, buildings, or vegetation at the back of the beach, that could effectively prevent hatchlings from leaving the beach, had a major impact on their mortality. When barriers were present, the majority of disoriented hatchlings eventually reached the ocean after protracted periods of moving in the wrong direction. The significance of the energy wasted during this wandering is not known. Whether disorientation continues in lighted areas after hatchlings have reached the water has not been investigated. Much has to be resolved before the full impact of lighted coastlines can be properly evaluated. For a comprehensive treatment of this topic see the review of this problem and potential solutions by Raymond (1984).

Sand Conditions

The percent of hatchlings successfully emerging is influenced by local sand conditions. Hatchling mortality within nests was greater on soft beaches with coarse-grained sand than on firm, fine-grained beaches. This may be due to a number of variables. It appears that hatchling emergence nest chambers in soft loose sand are prone to spontaneous, or hatchling-induced cave-ins, making escape difficult.

With externally applied pressures, such as those from people walking over the nests, or vehicles driving over the nests, which would include recreational off-road vehicles or beach maintenance machinery, mortality within the nests may increase. Due to compaction the hatchlings can get trapped in their nests. It appears that on firmer beaches these influences do not take such a great toll.

Between the sand particles of the beach is a diverse fauna including bacteria, protozoa, and small invertebrates. To what extent these faunas vary with beaches having different characteristics and how these differences may affect eggs and hatchlings has not been investigated.

Off-Road Vehicles, Vegetation, and Erosion

Much work has been done documenting the effects off-road vehicles have on dune vegetation and erosion (Brodhead, 1979; Brodhead and Godfrey, 1979). Dunes near the ocean can provide critical habitat for nesting females. If these dunes are affected, this can affect their value as nesting beaches. Females appear to key into the slope of the beach and the distance to the dunes when they are selecting a nesting site. The female turtles will not travel very far on land, so they seem to require beaches that are steep enough to provide a short distance to the dunes. If erosion processes are accelerated by off-road vehicle impact, then even if the eggs are laid they may be killed by overwash, or due to the erosion they may be taken by the ocean.

Where turtles lay their eggs on the dunes may be related to the presence or absence of beachgrass (Ammophila sp.). It has been found that beachgrass rhizomes will attack turtle eggs, robbing them of their nutrients, and kill them (Lazell, 1981).

Hatcheries

When eggs are laid in high risk areas, often the only option is to move them to a hatchery, which poses new problems. When eggs are moved, the time that has elapsed from when they were laid until the time the eggs were removed has a significant effect on hatching success. Mortality increased significantly when the elapsed time exceeded 12 hours (Richardson, 1978). This may be due to a settling in effect of the embryo in the egg which can become vulnerable to the move after a certain critical period.

It has also been observed that just the handling of eggs has an adverse effect on their hatching success. This may be attributable to a transfer of bacteria from the researcher's hands to the eggs. This effect is currently being investigated.

Urine

It has been observed that after laying her eggs and before covering them up the female appears to urinate on them. It may be tempting to think that these are not particularly intelligent creatures, and they just happen to relieve themselves whenever nature calls. But one can speculate that this fluid may be important to the clutch, either by some sterilizing effect or by creating an environment that somehow is more conducive to their hatching. Another possibility might be that this fluid has a masking effect, be it olfactory or otherwise, which could render the nest less likely to attract the attention of potential predators. A better understanding of each of the above questions might lead to increased yield at hatcheries as well as better nesting beach management.

Oil Spills, Water Pollution

Recently we have seen the added threat to marine turtle nesting beaches due to oil spills, such as the one which just reached Galveston, Texas. At the same time we are witnessing a major, prolonged, potentially catastrophic ecological disaster which has been continuing for more than 4 years in the Persian Gulf, and has now extended to the Gulf of Aden, the Red Sea, and the Gulf of Suez (Smith, 1984). Combatants involved in the war between Iran and Iraq have been blowing up oil wells, oil terminals, offshore rigs, and oil tankers.

Sea turtles nest in this region. The short and long-term effects these hydrocarbons may have on nesting, hatching success, and hatchlings crawling back to the beach have not been evaluated. Dead turtles have been washing ashore throughout the region. The effects of petroleum on the development and survival of marine turtle embryos has been investigated by Fritz and McGee (1982). These hydrocarbons and other pollutants have introduced another factor. Certain chemicals may interfere with the olfactory cues sea turtles use for orientation during migration. Data support the hypothesis that by smelling and tasting the ocean currents and offshore waters, turtles may acquire necessary information which helps guide them back to their nesting beaches (Manton, Carr, and Ehrenfeld, 1972).

An additional problem, though not entirely restricted to nesting females, is that dead sea turtles, especially Leatherbacks (Dermochelys coriacea), have been washing ashore regularly in the northeastern United States. Autopsies have shown that the most frequent cause of death has been the ingestion of plastic bags, which can usually be traced to ocean dumping of trash (Garber, 1984b). These turtles naturally eat jellyfish, and mistakenly swallow the plastic bags which look similar, and the bags eventually kill the animals.

Other forms of pollution that may be having a detrimental effect on the turtles could include anything affecting the microorganisms living in nesting beach sand. How polluted groundwater might affect the microfauna living between the sand grains is not known. Also, when it rains, storm sewers are apt to dump increased amounts of human waste into the rivers, estuaries, and oceans. Waves and high tides can carry these polluted waters up and over the sands where the eggs are incubating. It is not known what effect this might have.

Predators

Another effect of off-road vehicles not mentioned above is that the wheels leave tracks which the hatchlings might have to climb up and over and through to reach the ocean. But sometimes these tracks are too deep and the sides too steep for the hatchlings to climb out, and instead they have no choice but to travel in the direction that the track goes, either right or left. Generally, once the turtles get stuck in these tracks the Ghost crabs find them, or they die from overheating or dessication and then the Ghost crabs find them.

Under normal conditions Ghost crabs do not always pose such a problem. It has been shown that at Cape Canaveral National Seashore Ghost crabs do not take a significant number of hatchlings (McMurtray and Irwin, 1982). However, at the sea island coastal region of South Carolina and Georgia, Ghost crabs accounted for 41% of the nest predation. Raccoons (Procyon lotor) also account for a large percent of the nest predation (Sandifer, Miglarese, Calder, et al., 1980). At Cumberland Island National Seashore in Georgia there is a population of raccoons that lives practically 6 months of the year almost exclusively on turtle eggs. And from the appearance of the raccoons during the rest of the year it appears they are not eating much the other 6 months. After the raccoons dig up a nest and consume its contents the Ghost crabs finish up any remaining eggs as well as any egg contents left behind.

There are other predators that have to be contended with. Wild pigs (Sus scrofa) dig up nests. And, depending on the locality, either due to over-grazing, digging up the eggs, or eating the hatchlings, feral ponies, dogs, cats, rats, and mice can have a detrimental effect. Most sea turtles hatch at night when avian predators do not pose a significant threat. Anything that might affect the time of hatchling emergence could therefore increase avian predation substantially.

Controlling raccoons and pigs by shooting them does not work very well because they are smart and become wary rapidly. And, since it is almost impossible to hunt down every last animal due to their high reproductive rate of increase, their numbers will quickly rebound to the carrying capacity. Likewise, trapping and poisoning are not advised either.

Global Effects

Global effects should also be considered. If the temperature of the Earth is increasing due to the Greenhouse Effect, or if weather patterns which have an effect on ocean currents are changing, what will the effects be on where females choose to lay their eggs? Sea temperatures of coastal waters in the southeastern United States appear to be getting colder. And data strongly indicate that sea levels are rising. Norbert Psuty and Karl Nordstrom delivered a poster presentation indicating a series of first steps being taken in anticipation of the rising sea level (1984). How will we respond if sea turtles respond to these changes by moving their nesting from those beaches which have been protected to new unprotected areas?

Recommendations

Concerning hatchling disorientation due to artificial beachfront lighting Raymond (1984) suggests identifying existing problem lights and modifying or eliminating them. He also feels that it would be valuable to establish standards and guidelines for acceptable beachfront lighting from which coastal lighting ordinances that restrict lighting could be written and enforced. It is also stressed that public education concerning hatchling disorientation is important.

Critical habitats where nesting occurs should be protected, which include not only the beaches but also the offshore areas. "Vigorous law enforcement and expanding public education should virtually eliminate poaching throughout the U.S." (Henderson, 1978). Bad publicity should be given to restaurants which carry turtle on their menu. Stores carrying turtle products should be reported. Law enforcement should be encouraged and supported. Beaches should be patrolled regularly during nesting and hatching season. Off-road vehicles should be controlled in key areas. Nesting sites should be protected from grazing animals in areas where erosion may threaten clutches. Where erosion is critical, eggs should be carefully removed shortly after being laid, incubated, and then released.

Shrimp trawls which catch and drown considerable numbers of turtles in their nets should be forced to trawl further back from the shore where they will catch fewer turtles, and by doing this they will preserve a greater portion of the shrimp spawning grounds. Net redesign to allow turtles to escape has also been suggested.

Turtle farms should be discouraged if their products are to be manufactured into soup or jewelry because it is impossible to tell whether the turtle products which appear in stores and restaurants were captured or raised legally or illegally. All turtle products should be strictly illegal.

Visitors and tourists are usually encouraged because of their input into local economies. Whenever possible these people are often interested in observing sea turtles, especially if they can see egg-laying or hatchling emergence. Where the turtles become part of the local economy, effort should be taken to limit detrimental effects. People should be kept off the dunes. Boardwalks can be built to provide ready access to the beach from behind the dunes. Signs should be posted along nesting beaches with the intent of keeping people off the dunes.

Since this country needs more wild areas where people can go for recreational purposes as well as more wild areas protected for wildlife, it is not always easy to control human use of critical areas. So it is absolutely necessary to combine public education with law enforcement if we are going to adequately manage the protection of marine turtles.

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TOWARDS DEVELOPMENT OF AN URBAN SHOREBASED RECREATIONAL FISHING ALLOCATION MODEL

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Introduction

This paper attempts to estimate the magnitude of urban shorebased recreational fisheries, both in terms of participants and fishing pressures. These estimates utilize an empirical recreational fishery allocation model. The data were obtained from a two-year survey effort conducted along New York City's shoreline.

Urban shorebased fishing constitutes a small portion of the nation's total recreational effort. Yet an estimated 81,000 New Yorkers annually fish from that city's shore (Heatwole and West, 1985). This figure does not include those who fish from boats nor does it include those who fish exclusively outside the city. These observations are mirrored in a number of other cities, and make clear that recreational fishing represents an important outdoor recreational opportunity for urban residents. For many of these people, opportunity for involvement in waterbased recreational activities such as swimming, boating, scuba diving, and surfing is scanty because suitable sites are few and often inaccessible. In addition equipment costs are often prohibitive. Shorebased fishing, on the other hand, occurs on nearly every type of shore environment and may offer lesser limitations on physical accessibility and cost.

Rationale

There are several reasons why coastal resource managers have become interested in assessing urban shorebased fishing. A growing number people who fish along urban waterfronts appear to do so primarily to supplement the family food budget. If this can be verified, it raises questions concerning health risks related to ingestion of contaminated fish. Another reason concerns the potential impact urban recreational fishing may have on fish stocks, as well as on the Fishery Management Plans (FMP) which have been developed for several species.

Since the vast majority of both finfish and shellfish spend a portion of their lifecycle particularly during their immature stages, in the nearshore marine environment it has been argued that fishing for species which are not yet fully grown represent an inefficient utilization of the resource base. Corollary concerns are the absence of recreational fish statistics and the need to issue recreational fish permits or licenses similar to those governing the fresh water fishery. The fourth and final reason for initiating this investigation is the magnitude of this activity as it relates to the stated goal by the CZMA -- to improve access to the shore to enable a greater proportion of the public to participate in waterbased recreational activities of which fishing traditionally has played a very important role.

The Setting

New York City is blessed with more than 570 miles of shoreline which include a barrier beach pond (Jamaica Bay), barrier beaches (Coney Island), tidal inlets (East, and Harlem Rivers), decaying urban waterfronts (much of the Bronx and Queens shoreline), urban waterfront developments (lower Hudson and East River), and the second largest natural estuary on the East Coast. This shoreline provides the residents with a multitude of different environments, much of it relatively accessible and nearly all of it used regularly for fishing. Even so, some sites are significantly more popular than others, in part because of their differences in size, ancillary facilities, and accessibility to public transportation.

Findings

Information for this study was obtained from 723 respondents who were interviewed during 1982 and 1983. Nearly two-thirds of those interviewed fished from one of the ten sites on which much of this analysis is based (Figure 1), with the balance distributed more or less randomly along the remainder of the shoreline.

More than twenty species of fin and shellfish were included in the catch, which totalled 1360 specimens. Two species (bluefish and crabs) accounted for more than three quarters of the total catch (Table 1). Only 252 of our 723 respondents (35%) had caught anything by the time the interview took place (Table 2), confirming previous findings that catch success is limited to a distinct minority of those who engage in sportsfishing (Bryan, 1976).

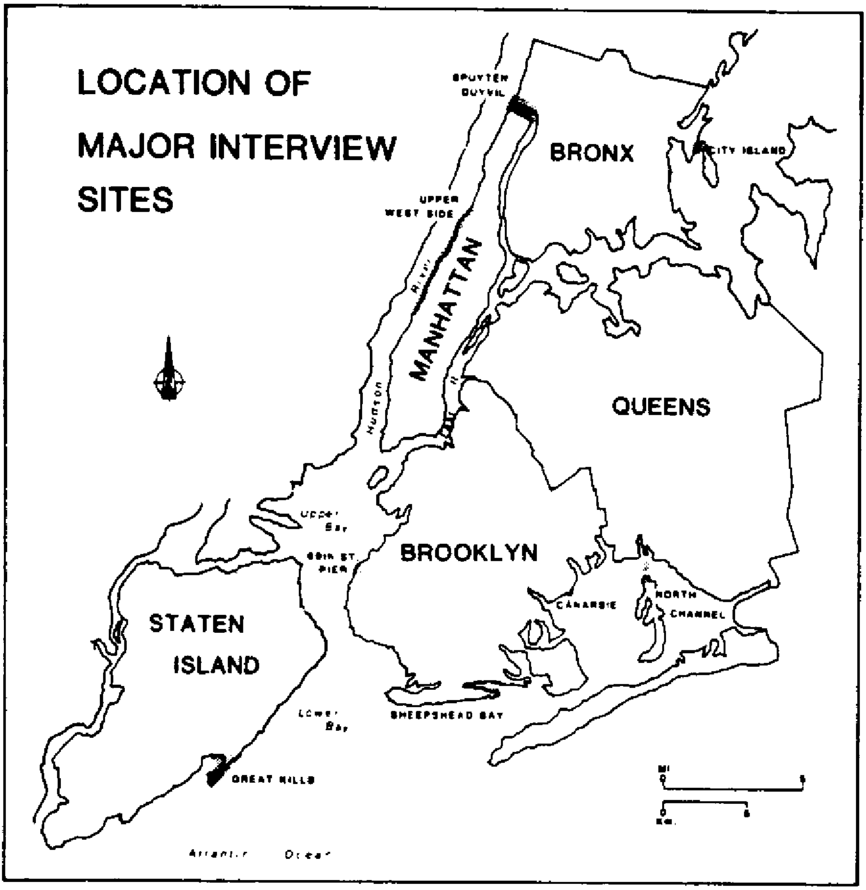

Figure 1. Location of Major Interview Sites

Specie	69th Pier	Sheepsh. Bay	Gravesend Bay	Canarsie	Broad Chan.	Midl Beach	GT Kills	City Isl.	Spuyter Duyvil	West Side	Sample Site	Total
Bluefish	59/7*	262/31	13/3	29/10	116/19	43/7	12/3	65/7	2/2	31/2	218/24	850/115
Crabs	7/4	12/3	2/1	19/5	9/4		26/7				115/15	190/39
Eels		1/1	1/1	1/1			1/1		55/17	1/1	16/6	76/28
Striper	3/1			20/9					3/3	11/4	22/6	59/23
Perches									27/6	16/1	4/2	47/14
Bunkers		5/1						9/1			4/3	18/5
Porgies			1/1	1/1			1/1				11/4	14/7
Flatfish	4/1	1/1	2/1	3/1							1/1	11/5
Tautog					6/1						1/1	7/2
Mackerels		6/1									0/0	6/1
Blackfish							3/2	1/1			0/0	4/3
Seabass					3/2						0/0	3/2
Other		1/1					2/1	60/2		1/1	8/2	72/9
Total	73/13	288/39	19/7	73/27	134/26	43/7	45/14	135/11	87/28	60/14	400/64	1360/252

* 59 refers to the Numev of fish (Bluefish) caught
7 refers to the Numev of fishermen with cattles.

Table 1

	With Catch	% w Catch	Without Catch	% w/o Catch	Total	Total # of Fish Caught	Mean Catch By Successf. Fish.	Mean Catch by Total Resp.
Respondents From Ten Most Popular Fishing Site	187 74.2	35.3	343 72.7	64.7	530 73.3	960 70.6	5.1	1.8
Respondents Outside Ten Fishing Sites	65 25.8	33.5	129 27.3	66.5	194 26.8	400 29.4	6.1	2.1

Table 2

We were interested in comparing catch success between the ten survey sites and all other sites as well as identifying similarities and differences within the ten sites. Catch success was determined on the basis of total number of fish caught by the time the interview took place and the number of hours spent fishing. Results from this analysis may indicate whether the popularity of a given site is related to fish abundance (resource related) or whether the popularity is influenced by socio-environmental factors including accessibility and perceived environmental amenities.

Nearly three quarters of the respondents (530) were fishing from the ten most popular sites (Table 2). However their popularity as a group do not appear to be related to the quantity of the catch. Those who had caught fish outside the survey sites by the time the interview took place were proportionally identical to those who had caught fish and shellfish within the ten sites. These figures only refer to those respondents who had caught fish and do not address the number of fish caught. When addressing catch in terms of total number of fish landed by "all fishermen" and "successful fishermen" a different picture emerges.

The successful fisherman fishing from within the ten sites had caught 5.1 fish by the time the interview took place, whereas the successful fishermen fishing outside the ten sites had caught 6.1 fish. Not surprisingly these differences are evident when dividing total catch by the total number of respondents. The average catch by all respondents within the ten fishing sites totalled 1.8 fish compared to 2.1 fish for those fishing within the ten sites and those fishing outside the ten survey sites respectively.

These figures suggest that the successful fishermen fishing from the ten popular sites account for less fish (70%) than would have been expected had catch been evenly distributed along an 570 miles of shoreline. This is further substantiated when comparing the average number of fish caught by the two groups. Successful fishermen at the ten major sites had caught about one less fish per person than successful fishermen interviewed elsewhere. Thus, the popularity of the ten sites appears to be less a function of catch success than some other factor like, accessibility, proximity, or perhaps perceived environmental amenities.

Table 3 summarizes catch statistics for the ten sites included in these analyses. Fairly significant variations exist among them even when controlling for the number of fishermen. Brooklyn's 69th Street pier, which overlooks lower Manhattan, the Lower Bay, Staten Island and the New Jersey shoreline, is the poorest fishing site. Only 16.5% of the respondents had caught something by the time the interview took place. The next poorest sites were Gravesend Bay and South/Midland Beach, each with less than 20% of the respondents reporting a catch. At the other end of the continuum, catch success rates at Canarsie, Broad Channel, (both located along Jamaica Bay) and Spuyten Duyvil are probably some of the most biologically productive in New York City.

PARTICIPANTS, CATCH & CATCH EFFORT BY FISHING SITE

Fishing Site	Total Nos. of Respond		Respond. w/ Catch		Respond. w/o Catch	
	Nos.	%	Nos.	%	Nos.	%
69th Street Pier	79	10.9	13	16.5	66	83.5
Sheepshead Bay	81	11.2	39	48.1	42	51.9
Gravesend Bay	36	5.0	7	19.4	29	80.6
Canarsie	48	6.6	27	56.3	21	43.7
Broad Chan.	52	7.2	26	50.0	26	50.0
South & Midl.	23	3.2	7	30.4	16	69.6
Gt. Kills	77	10.7	15	19.5	62	80.5
City Island	33	4.6	11	33.3	33	66.7
Spuyten Duyvil	58	8.0	28	48.3	30	51.7
Upper West Side	43	5.9	14	32.5	29	67.4

Table 3

Specifically, Canarsie and Spuyten Duyvil have catch ratios varying from 56.3% to 48.3%. While considerable variation exists within the ten sites, it appears that some of the water bodies may still have a considerable way to go before full biological productivity has been reestablished.

Perhaps a more relevant estimate of catch success analyzes the number of fish caught at a given site in conjunction with hours of effort. These results appear in Table 4. No strong correlation exists between catch success and the time spent fishing.[1] This finding has been verified in other studies dealing with fishing where catch success appears to be only one of several variables affecting or influencing the popularity of a given site. Clearly, catching fish is only one reason why urbanites go fishing. Others may include socializing, enjoyment of the outdoors, excitement associated with the "bite", and food supplementation.

Catch Effort Model

Of the variables included in the analysis, catch effort "E" is probably the single most important parameter. This coefficient is estimated from model 1:1.

$$E = \frac{C}{R \times T_E} \qquad 1:1$$

where

1 = significant alpha .05 Spearman Rank Correlations - .27 not statistically

C = Aggregate number of fish caught for the total sample at a particular site by the time the interview took place.

R = Total number of respondents at a particular site.

TE = Average number of hours spent by the respondents by the time the interview took place.

On the basis of the results generated from this model it would appear that the Sheepshead Bay, and Broad Channel are the most productive fishing sites included in the analysis. The least productive sites include Great Kills and Gravesend Bay (both located along the Lower Bay), City Island and the 69th Street Pier.

1 Spearman Rank Correlation -.27, not statistically significant alpha .05

SELECTED CATCH STATISTICS BY FISHING SITE

	Number Of Fish Caught	Number Of Hours Spent On Site	Additional Hours Exp. To Be Spent	Total Hours To Be Spent On Site	Catch Effort
	C	T_E	T_A	T_N	E_C
69th Street Pier	73	2.7	2.8	5.5	.34
Sheepshead Bay	288	2.6	3.4	6.0	1.37
Gravesend Bay	19	2.0	3.4	5.4	.26
Canarsie	73	2.2	2.0	4.2	.45
Broad Channel	134	2.6	2.8	5.4	.99
South & Midland	43	2.4	3.1	5.5	.78
Great Kills	45	2.4	2.4	4.8	.24
City Island	135	3.7	4.1	7.8	.27
Spyten Dyvil	87	2.2	2.7	4.9	.68
Upper West Side	60	2.8	2.6	5.4	.49
Outside	400	2.4	2.7	5.1	.86

Table 4

Fishing Allocation Model

The second part of our analysis is an attempt to project the average catch in a given year. When making such estimates some qualifications should be kept in mind. One is that fishing success may vary from year to year. It has long been known that a number of species sought by New York's recreational fishermen are subject to wide gyrations. The reason(s) for fluctuation are not fully understood. Species characterized by large-scale year class variations include the Striped Bass and Bluefish, and perhaps Butterfish and Menhaden as well. While the total biomass probably remains fairly constant, these variations may significantly affect catch success and catch efforts of individual species. It is also assumed that some lag time exists between the appearance and disappearance of large schooling fishes and the time the sports fishing community has adapted to these new fisheries.

Other qualifications relate to the data to be entered in the model. Projections are based on information provided as "best estimates" and may not necessarily be normally distributed in a statistical sense. Consequently, the estimates should be viewed with considerable caution until such time as a city-wide creel census can be implemented. Finally the magnitude of the catch, should be tempered by the absence of data on the weight and length of fish landed. Also in our specific case, no attempt was made to allocate the catch on a per specie basis. The catch statistics simply are not of sufficient quality to enable more accurate estimates and projections. The operational model 1:2 takes the following form:

$$C_L = P_F \times F_F \times (T_E + T_A) \times E \qquad 1:2$$

where

C_L = number of fish caught by fishing location

PF = number of persons from a specific location

F_F = mean fishing frequency per year

T_E = number of hours already spent fishing at the site

TA = Additional of hours the respondent anticipates to fish at the site

E_C = Catch effort previously defined.

Based on this model a total of 11.7 mill fish are estimated to have been caught within the N.Y.C. shoreline, 27% of which is being caught outside of the ten sites (Table 5).

PROJECTED CATCH ESTIMATE PER FISHING SITE

	Population	Fishing Frequency	Total Hours Spent Fishing	Catch Effort Effort	Projected Catch
	P_F	F_F	T_N	E_C	C_L
69th Street Pier	8829	39.6	5.5	.34	653,805
Sheepshead Bay	9072	63.6	6.0	1.37	4,742,769
Gravesend Bay	4050	59.9	5.4	.26	339,762
Canarsie	5346	32.5	4.2	.45	328,378
Broad Channel	5832	57.4	5.4	.99	1,789,609
South & Midland	2592	69.2	5.5	.78	769,481
Great Kills	8667	36.6	4.8	.24	365,428
City Island	3726	52.7	7.8	.27	413,534
Spuyten Duyvil	6480	66.9	4.9	.68	1,444,462
Upper West Side	4779	70.8	5.4	.49	895,282
Subtotal	49373		5.1	.86	11,742,510
Outside Study Sites	21627				
Total	81000	49.9			16,151,269

Table 5

Not surprisingly, the fishery originating from Sheepshead Bay, Broad Channel South/Midland, and Spuyten Duyvil account for the largest landings. Two reasons may account for this. First, these four sites were identified by landings having somewhat higher catch effort ratios compared to the remaining sites. Second, the larger landings may relate to the relatively longer visits or the greater number of visits which the respondents reported from these sites. The four most successful sites appear to be located on those portions of the waterfront which are somewhat cleaner and subject to greater tidal flushing thus reducing the potential health hazards which may be associated with the consumption of contaminated fish.

Conclusions

The first objective concerned the problem of fishing pressure. The number of fish caught may appear impressive and warrant consideration of a management scheme. But there are persuasive reasons why licensing or other fishing controls should not be initiated at this time. Assuming a four-month fishing season, 570 miles of shoreline, of approximately equal fishing pressure on every section of the waterfront, only 153 fish are being caught per day per mile of shoreline (one fish for every 35 feet). This can hardly be considered a threat to the nearshore ecology, particularly in view of the fact that many of the species sought are seasonal.

The second objective concerned physical access and accessibility as it relates to fishing efforts and success. While fishing is conducted on nearly every mile of shoreline, the majority of fishing takes place at relatively few sites, not all of which have been exclusively designated for fishing purposes.

Based on these conclusions, it would appear that the fishing pressure currently sustained is low with ample room for expansion.

End Notes

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THE APPLICATION OF DESIGNED ARTIFICIAL REEFS IN COASTAL MITIGATION/COMPENSATION AND FISHERIES DEVELOPMENT PROJECTS

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Our coastal and estuarine ecosystems have been stressed and even reduced by the environmental impacts of various types of development activities such as channel and stream diversions; dredging, filling, and land reclamation; spoil and waste disposal; offshore construction; and pollution of all forms. Increasing fishing pressure, combined with this habitat loss and pollution, has also contributed to serious declines in some of our most important fisheries. Because many of the affected areas constitute critical habitat for our living marine resources, there has been a growing concern over the long term adverse effects of such alterations and fisheries losses.

This concern has stimulated aggressive efforts to conserve and enhance the remaining habitat in order to maintain its productivity and compensate for unavoidable losses or degradation. Active programs are now underway in many areas to control pollution and to more effectively manage and, in some cases, augment selected stocks. However, options for replacing or compensating for habitat losses have been limited and new approaches are required if we are to protect these coastal areas from the effect of continued growth.

Efforts to mitigate or compensate for the loss or degradation of aquatic habitats are not new. Historically, mitigation/compensation efforts have included projects to re-establish passage for anadromous species through channel modification or fishway construction, or have provided wetland and shallow water enhancement through marsh creation, mangrove afforestation, or the establishment of seaweed beds. Most of these techniques have been restricted to upstream or shallow estuarine areas. Effective compensation methods for increasing the carrying capacity of open water areas have been lacking.

Artificial reefs are potentially promising tools for expanding mitigation/compensation efforts into open waters. For many developed estuarine and urban coastal areas, the enhancement of the remaining open water habitat may be the only practical method of compensating for losses of open water habitat. Traditionally, artificial reef construction in the U.S. has been directed toward the improvement of recreational fishery catches and has been restricted to the use of scrap or salvaged materials such as old tires, construction, rubble, and surplus ships, none of which is appropriate for compensatory reef construction. However, a new approach utilizing prefabricated designed reef units has been recently introduced into the U.S. This new technology is well suited for compensatory reef construction and also increases the effectiveness and siting options for fisheries development projects.

Selected aspects of this technology are now being applied by Aquabio to provide new options for mitigation and compensation as well as to enhance American fisheries development. Aquabio's fishery enhancement program objectives include:

- Identification of problems impeding artificial reef development in the U.S.
- Identification of new methods and technologies with potential for improving reef development.
- Selection of appropriate technology for testing and evaluation
- Comparison of the new technology with traditional approaches
- Adaption and application of the best available technology to promote fisheries development and provide habitat enhancement capabilities

<u>Problems Impeding Reef and Fish Attractor Development</u>

To identify the most common problems impeding artificial reef development in the U.S., we reviewed available information files and interviewed other researchers, fisheries and environmental administrators, and fishermen. In addition, a series of surveys and site dives were conducted to evaluate the results of past reef construction.

Results suggested that there were four common operational problem areas:

- Limited period of effectiveness or life expectancy for the reef
- Liability concerns associated with the loss or movement of reef materials
- Limited siting flexibility due to design and material constraints
- Cost and availability of transportation equipment for placement

Many of these problems are directly related to reliance on scrap or salvaged materials for reef construction. The limited design flexibility of scrap or salvaged items restricts their effectiveness, life expectancy, and siting options. Attempts to site such reefs as close as possible to access points have resulted in the loss or movement of these materials or units, and have led to serious liability problems. Low density reef materials such as tires have moved off of permit sites and onto beaches or have ended up in commercial fishing gear. Even high density items such concrete culvert have been observed rolling over live bottom areas destroying coral habitat. Large steel ships have completely disappeared from permitted sites after major storms.

In addition, our investigation also indicated that although many scrap or salvage items are "free" in terms of material procurement costs, the costs of storage, handling, preparation, and placement are often substantial, especially considering the effective life of the enhancement. Many of the costs associated with such construction are "buried" in budgets for capital expenditures, fees for other services, or even proposed tax credits to be subsidized ultimately by the taxpayers at large, and are frequently ignored when the costs of such projects are assessed. Obsolete offshore petroleum platforms, which on several recent occasions have been cut off below the bottom, hoisted, moved, and reinstalled as artificial reefs, are especially expensive to transport and offer limited siting options for coastal mitigation/compensation or fisheries development applications without further cost escalations.

East Asian Artificial Reef and Fish Attractor Technology

To identify alternate methodologies with potential for improving American aquatic habitat and fisheries enhancement efforts, Aquabio examined approaches which have been used successfully in other areas. Our investigations focused on Japan and to a lesser extent, Taiwan, both of which have invested substantially in research, development, test, and evaluation of designed reef technology and have implemented some of the most extensive artificial reef programs in the world.

As with American artificial reef programs, early Japanese and Taiwanese efforts utilized both natural and scrap materials. However, the Japanese and Taiwanese soon recognized the limitations of these materials and determined that designed prefabricated structures were generally more cost-effective over the long term.

The first generation of designed reef units used in Japan and Taiwan consisted of prefabricated concrete units shaped as hollow cubes or cylinders cast in one piece and measuring 1-2 meters on a side. They were usually deployed in piles to provide a higher profile.

Field and laboratory studies conducted in both Japan and Taiwan during this period indicated the desirability of producing larger, higher profile reef units which would function to support as well as to attract bottom and midwater species. It was also determined that a variety of designs which would permit habitat enhancement projects over a greater range of oceanographic conditions would be required. Extensive research, development, test, and evaluation has now produced a new generation of designed reefs which have proven to be very effective, have life expectancies of 30 years or longer, and are suitable for a wide range of applications.

Evaluation, Selection, and Transfer of Technology

Our initial assessment of East Asian technology followed two years of extensive field research in Japan and Taiwan in cooperation with the researchers and managers responsible for applying and monitoring these programs. Results of these and ongoing cooperative exchanges indicated that some aspects of this technology, when appropriately modified, have potential for application in American habitat compensation and fisheries development projects. We determined that transfer of this technology would permit us to benefit from the extensive research and development investment already made by the Japanese and Taiwanese, and thus significantly reduce the cost of applying this technology in the U.S.

Of the wide variety of reef units available in Japan, not all were suitable for American applications due to significant differences in the motives, methods, and budgets for reef construction. Specific criteria which we used when screening and selecting units for our tests and evaluations in the U.S. included:

- Design and siting flexibility
- Effectiveness for target species or communities
- Chemical and physical stability to ensure a long life span
- Long-term cost-effectiveness, given American logistics
- Adaptability for small scale compensation and fishery development projects.

These criteria were important since reef objectives, target species, coastal oceanographic conditions, scale of operation, and construction cost factors are quite different in the U.S.

Operational Testing and Evaluation

For our initial testing and evaluation of designed artificial reefs, we chose units composed of cylinders fabricated from fiberglass reinforced plastic (FRP) because they were especially suited to immediate American needs and applications. These units are extremely flexible in terms of design, size, and configuration, and can be readily adapted to the different conditions and target species found in American waters. The units can be transported and built with a minimal amount of heavy equipment and skilled labor. In addition, they can be placed without using the expensive floating cranes and barges typically required for other units.

Three sites off Florida were selected for our comparison study (Figure 1). Work began in August, 1981 with the construction and placement of FRP units in 21 meters of water off Panama City and Jacksonville. Units were also placed in April, 1982 at a third, shallower site (12.6 meters) off Clearwater to facilitate more detailed studies.

A comparison concrete culvert reef composed of scrap culvert from 1-2.5 meters in diameter, typical of a common type of American scrap material reef, was built at each site for comparison purposes. In each case, the void volume of the culvert and FRP reefs were approximately equal. All sites had flat coarse sand bottoms devoid of natural relief. Preplacement surveys indicated a very sparse fish population at each site.

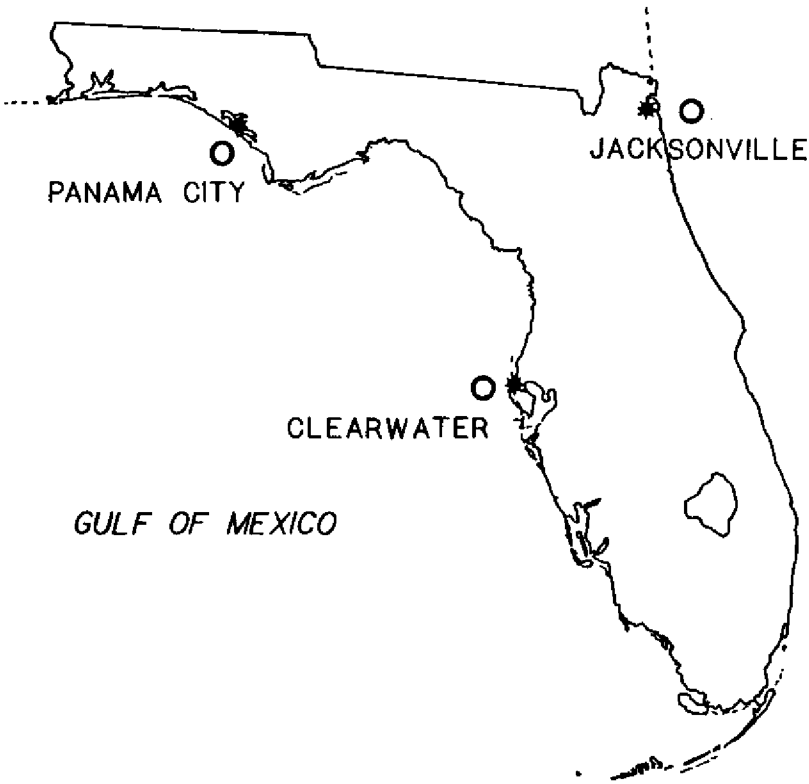

Figure 1. Map of Florida showing Aquabio research sites for FRP and culvert.

Several different types of FRP units were built as part of a long-term stability test. Figure 2 shows the unit types in cross section with the basic cylinder components, guard bars, ballast concrete, and anchor piles.

The open-wind FRP cylinders used to construct the units were about 5 meters long and ranged between 1-1.5 meters in diameter. Based on site conditions and target species, the components were erected in four predetermined forms. All components were fiberglassed together and the units were ballasted with concrete, with the amount of ballast adjusted to site-specific requirements as established by extensive wave tank testing and field trials.

Special reusable air bags were inserted into the lower cylinders to permit the units to be floated and towed to site after placement in

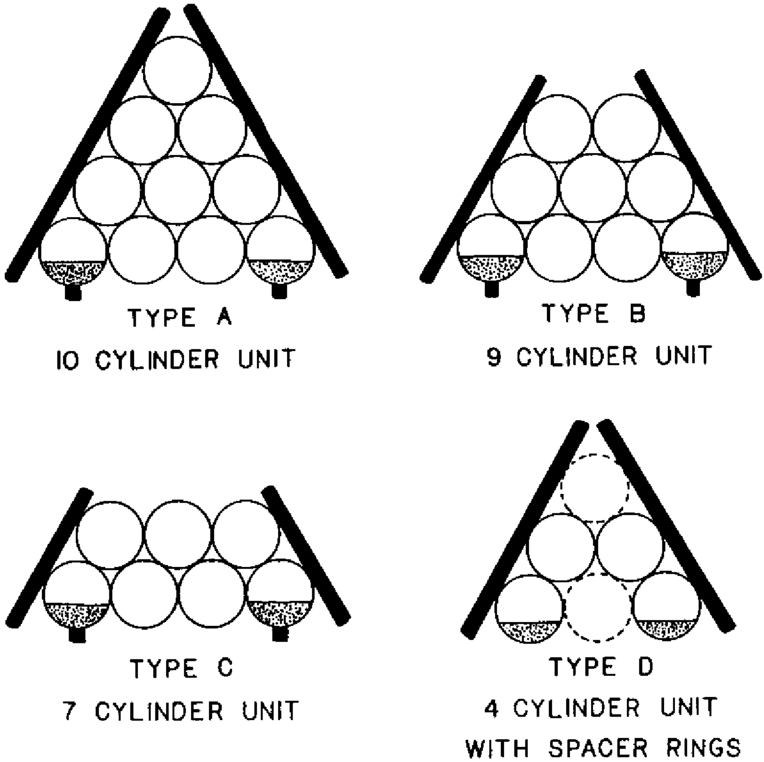

Figure 2. FRP reef unit types deployed at Aquabio research sites in Florida.

the water. This method essentially eliminates the requirements for barges and floating cranes typically needed to place most other reef units.

After being towed to site, the units were detached, maneuvered into final position, anchored, and oriented. Upon being vented, the units sank in place. Airbags and lines were recovered and retained for reuse.

Our comparison studies were designed to examine reef stability, fish species composition and relative abundance, and benthic community development. Additional special studies on the forage base and primary productivity were also conducted when time permitted.

Detailed results of this study will be reported in the literature in the near future. Results clearly indicated that the designed FRP reefs were superior to the traditional scrap culvert reefs in terms of attracting and sustaining desired target species of fish, forage species, and juveniles. In general, benthic fish densities on the FRP reefs were 2-6 times greater than those on the comparison culvert reefs. Pelagic species were at least ten times more abundant on the higher profile FRP reefs. Stomach content analysis indicated that many of the fish sampled were feeding on the forage base provided by the reef, thus the reef provided not only shelter and orientation cues, but also a food base as well.

The encrusting community, which is especially important for compensatory applications, was 5-9 times more abundant on the FRP reefs despite a surface area advantage on the culvert. The diversity of the encrusting community was also significantly greater on the FRP reefs.

Applying the New Technology

The introduction and adaptation of this new technology for use in the U.S. will permit the expansion of the range of sites and conditions where enhancement can be applied and will facilitate new applications. In addition to their traditional function in the U.S. for increasing coastal recreational fishing opportunities, designed artificial reef units can be used for marine and estuarine mitigation/compensation, extensive aquaculture, nursery or spawning ground creation, and commercial fishing.

Because the design flexibility of prefabricated units allows reefs constructed from them to be optimized in terms of siting, configuration, aspect ratio, and overall effectiveness for target species or communities, they are particularly suited for applications such as compensation which have long-term maximum effectiveness per unit bottom area as their primary objective.

As is the case with many technological advances, the application of designed reefs will certainly not solve all problems, and the availability of such effective tools is not a substitute for conservation and sound management of the resources. This technology must be applied with careful consideration. Improperly applied, it could adversely affect some stocks by making them more vulnerable. This is particularly true of fish attractors, which serve only to attract or concentrate fish rather than potentially increasing carrying capacity or production. In addition, the availability of designed reefs for mitigation/compensation should not serve as an excuse to permit further degradation and loss of important natural habitat.

Summary

The results of our research and testing suggest that when long-term ecological or fisheries benefits are the primary objective of an artificial reef project, prefabricated designed units offer a number of advantages over scrap material reefs. This is particularly true where available sites are limited, intense fishing pressure is anticiapted, special oceanographic conditions exist, or the best available technology is required. The designed reefs selected for our initial research proved to be very effective for fish, benthic, and biofouling communities and are particularly suited for American coastal and estuarine reef construction projects due to their design flexibility, stability, and ease of erection and placement. These reefs can be effectively used for mitigation/compensation projects, fisheries enhancement, extensive aquaculture, or sanctuary development. Other units and systems are now undergoing evaluation and will be tested in the near future.

The transfer and adaptation of aspects of this new technology is a cost-effective method for improving fishing opportunities and maintaining the carrying capacity of our vital coastal areas. Aquabio's program to evaluate, select, modify, and apply this technology in the U.S. has resulted in the introduction and adaptation of designed artificial reefs which are now ready for application.

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GAMBLING WITH LIABILITY FOR ACCIDENTS ON BEACHES

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Public and private owners of beach property take calculated risks when they allow the public to use their beaches. In essense they gamble that the one in a million chance of an accident doesn't cost them a million. Accidents can and do happen everywhere--on the sand, in the surf, in the bathhouse, at the concession stand---but the mere fact that a beach user is injured doesn't mean the beach owner is liable for damages. It is only when the beach owner's breach a legal duty of care causes a visitor injury that legal liability risks arise. This paper describes a beach owners liability for visitor accidents and injuries caused by defective conditions or hidden hazards on the beach and in the water. It is based on a review of court cases and state statutes. In essence, the legal mistakes and misfortunes of others provide the basis for this discussion.

In legal parlance, the risk most beach owners face falls in a category called negligence. The law of negligence requires beach owners to exercise the degree of care of a reasonable and prudent person to prevent unreasonable risks of harm.[1] As the risk of harm increases the owner must adjust management practices to prevent the risk from becoming unreasonable. The owners degree of control over the beach and the water is essential in defining this legal duty. Other controlling factors include the visitors status, state recreation use statutes and tort claims statutes.

STATUS OF BEACH USER

In most states, the beach owners legal duty of care is determined by the status given to the visitor. Beach users are categorized as **invitees, licensees** or **trespassers** with each receiving varying degrees of legal protection. Basically, invitees receive the greatest protection, licencees moderate protection and trespassers scant protection.

Invitees are persons who are expressly or impliedly invited on a beach for some purpose connected with the beach owners business or for the mutual interest of both parties. Thus a user of a publicly owned beach, or a user who pays a fee to use a privately owned beach, is an invitee. The owner is not an insurer of an invitees safety. An owner has a duty to inspect the beach, water and related facilities to discover hidden hazards, remove those hazards or warn the invitee of their existance and to take reasonable precautions for the safety of the invitee.

A licensee is a visitor who is privileged to enter the beach by the owners consent and is generally referred to as a social guest. Visitors using a private beach with permission, but without paying a fee, would be considered licensees. Owners have a duty to warn licensees of known hidden hazards but they do not have a duty to inspect the beach and surf to discover hidden defects. If a hidden defect, such as a submerged pipe, causes an injury and the beach owner was unaware of its existence there is no liability.

Trespassers receive scant legal protection under the law. They are users who are on the beach without the owners permission or consent. As a general rule, beach owners do not have a duty to warn trespassers of any hidden dangers nor to protect them from such dangers.

A few states do not follow this tripartite system for establishing liability but hold the owner to a single duty of care for all users, except trespassers. The coastal states of Alaska, California, Hawaii, Louisiana, Maine, Massachusetts, New Hampshire, New York, and Rhode Island have abolish the licensee and invitee distinctions for establishing a owners duty of care.[2]

RECREATION USE STATUTES

In the absense of state statutes, the invitee, licensee, and trespasser rules apply to an owner who allows the public to use the beach for recreation purposes. Recently, there has been a statutory trend to changes those rules of law. Recreation use statutes in all states,except Alaska, Mississippi, Rhode Island and Utah, have altered the owners duty of care to the gratuitous beach user. Typical of the wording of these recreation use statutes is the Maryland Act providing that the landowner who invites or permits, without charge, persons to use their property for recreational purposes:

> "Owes no duty of care to keep the premises safe for entry or use... or to give warning of a dangerous condition, use, structure or activity on the premises to any person who enters the land for these purposes" or "Confer upon the person the legal status of an invitee or licensee to whom a duty of care is owed."[3]

A reading of these two sections suggests that the recreation beach user is downgraded to the status of trespasser. Thus, the beach owner is only liable for wilful or wanton misconduct which injures the beach user. In effect, recreation use statutes offer a statutory promise that an owners consent to free use of the beach will not subject the owner to liability for user injuries.

GOVERNMENTAL IMMUNITY

A beach users ability to recover for an injury caused by a hidden hazard is often based on the ownership of the beach. While the aforementioned standards of care have been applied to both public and private beach owners, the doctrine of governmental immunity must be considered. All the coastal states, except possibly Georgia, have judicially or statutorily abolished or modified the doctrine of governmental immunity thereby allowing lawsuits against public agencies for user injuries on their beaches. [4] Specific reference must be made to each statute to determine the exact basis for recovery.

HAZARDOUS CONDITIONS

In analyzing beach owners liability for accidents, specific types of forseeable risks presented by hazardous conditions must be assessed. The risks associated with beach usage depend on the physical characteristics of the beach, authorized recreation activities, beach user characteristics and water conditions. A beach owners duty of care is governed, in great part, by the risks associated with these conditons. A number of cases have arisen wherein the courts have considered liability of the beach owner for an injury or death which allegedly resulted from a condition in a bathhouse, deck, pier or other area in the vicinity of the water. In those cases where the owner was liable for injuries to the invitee, the courts found that the hidden defect presented an unreasonable risk of harm and the beach user acting in a reasonable and prudent manner was not aware of the condition. Illustrative of this line of cases is **Bilbao v. Pacific Power and Light Co.**, 479 P. 2d 226 (Oregon 1971) wherein the court found the owner of the beach liable for an injury sustained by a visitor who tripped and fell on an anchoring cable. Observing that the cable was rusty in color and blended in with the sand, that it extended 4 inches above the sand in an area heavily used by beach visitors, that at least one other person fell over the cable on the day of the accident, and that no attempt was made to mark the cable or warn of the danger, the court concluded that the cable was a hidden defect.

Contrary results have been reached in a number of cases where the injured party was aware of the hazard and continued the activity. Indicative is **Friedrich v. Dept. of Transportation**, 586 P. 2d 1037 (Hawaii, 1979), where a pedestrian, who was rendered a quadrapalegic as a result of a fall off a state owned pier, brought action against the state seeking recovery of damages. The Supreme Court held that evidence, including testimony of the plaintiff, supported findings that the danger of entering the damaged pier was obvious and that the plaintiff was fully aware when he chose his path, both of the conditions which created the accident and of risk that he might slip and fall and thus the state did not breach its duty of care to warn of hidden defects.

These cases illustrate that a owner who extends an invitation to the public to use the beach has a duty to inspect the premises to discover hidden hazards. After discovering hidden hazards that pose unreasonable risks of harm to beach users the owner has an obligation to remove the hazard or warn the user of its existance. A failure to issue an adequate warning constitutes an unreasonable bet in gambling with an injury and a lawsuit.

A second type of associated risk for the beach owner is presented by hidden hazards in the water where an injury results from the owner's failure to warn against deep water, objects floating or submerged in the water, diving in shallow water, or a condition of the water. In cases involving these risks, the courts have frequently held the beach owner liable. Thus in **Buchanan v. City of Newport Beach**, 123 Cal. Rptr. 338 (Calif. 1975) the court held that there was sufficient evidence to support a finding that the city's failure to warn of a dangerous surf condition was the cause of the plaintiffs injury. The facts in this case show that while the plaintiff was "body surfing" at a beach called the "Wedge," he was thrust down into the sand by the action of the wave he was riding, thereby breaking his neck. This beach was created by a construction of a jetty to protect the harbor entrance and from the depositing of dredged sand on the beach. The man-made condition of the beach, plus the interaction of the ocean swells against the jetty caused a refraction of the waves and at times produced a dangerous surfing condition. No warning signs were posted advising surfers of this dangerous condition even though the city had actual knowledge of the danger.

A related line of case holds that if a reasonable inspection would not reveal a hidden defect, or if a beach owner provided an adequate warning of hidden hazards and the user voluntarily encountered the danger the beach owner has no liability. Thus in **Wamser v. City of St. Petersburg**, 339 So.2d 244 (Florida, 1976) the city was not liable for an injury sustained when a swimmer was attacked by a shark at a city beach. The evidence disclosed that the plaintiff was swimming 25 feet from shore and about 15 feet from the lifeguard when the attack occurred. Prior to the attack there were no sightings of sharks in the area nor had there been any previous shark attacks at this beach in its 24 year history. The court concluded that in the absence of a reasonable forseeability of the danger, there was no duty on the part of the city to guard against an attack or to warn of such an occurrence.

SUMMARY

Accidents, injuries and liability present triple concerns for public and private beach owners. When accidents and injuries are caused by the owner's breach of a legal duty of care, liability may be imposed. The law is replete with case examples of owner liability based on the failure to protect beach users from unreasonable risks of harm. Several guidelines can be drawn from the legal misfortunes of others to formulate beach management practices.

When a owner invites the public to use a beach for recreation purposes a legal obligation is recognized by the courts. That obligation translates into a legal duty of care. The owner is not the guarantor of the users safety but must act with that degree of prudence and foresight of a reasonable man to prevent unreasonable risks of harm. Translated into a management practices the owner has a duty to:

(1) Inspect the premises to discover hidden hazards,

(2) Remove those hazards or warn the user of their existence, and

(3) Conduct operations on the beach with reasonable care for the safety of the visitor.

While the duty may be modified by state recreation use statutes, or tort claims statutes, the beach owner would be well advised to consider these management practices to minimize unreasonable legal risks.

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2. Ibid, p.433

3. Maryland Annotated Code §§ 5-1103-1104

4. See Restatement (Second) of Torts, § 895 B for a status of governmental immunity.

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RISK MANAGEMENT AND COASTAL STORMS OF 1982-1983

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Living in California eminently qualifies me to talk about risks, since most of us in that state live with the threat of every natural calamity known to man; earthquakes, flooding, mudslides, brush and forest fires, carbon monoxide poisioning, you name it! We have adapted to the risk quite well with little thought given to the consequences, until immediately following a major event, and at that our awareness only lasts for a short time before we are back to business as usual.

Prior to 1983, one type of natural disaster we had not come to expect was major coastal events. And that is what I want to share with you today . . . California's experiences with its coastal storms of 1982-1983.

The California Coastal Storms of 1983 are grim reminders of the risk associated with development of coastal areas. Prior to the occurrence of those storms it was difficult if not impossible to articulate the adverse consequences that could someday result from major coastal disturbances.

It was difficult to envision storm waves powerful enough to crush concrete, splinter piers, and perhaps most incredible of all, sweep away the top eight feet of many of our reach areas. It was difficult to imagine tornados in Southern California--twisters strong enough to uproot trees and cause major damage to businesses and residences.

Yet, those were exactly the unusual weather phenomena that occurred in California throughout the storms of 1982-1983. Pacific storms pounded the California coastline with awe-inspiring 15-25 foot breakers that caused massive damages up and down the coast to numerous structures built of heavily reinforced concrete or protected by stonework.

Many questions remain unanswered in the wake of these devastating storms. Questions such as--how rare are storms, waves, and tides of this magnitude? Could a future storm be even more severe than the storms of 1982-1983? How can we best prepare our coastline to withstand repeated battering and severe erosion? Or even more dramatically--should we abandon existing coastal development and let nature take its course?

While only the passage of time can answer these questions adequately, we need to form attitudes about risks today in order to prepare for future coastal storms. These are attitudes which can take years to form, based on the ocean's cumulative effects on our coast. In addition we must have better coastal data on which to base important decisions. The development and refinement of design criteria, construction methods and use of good judgement in selecting building sites are keys to successfully minimizing the destruction of a major coastal storm. However, only a change in attitudes will prompt us to be more cautious.

I would like to focus my comments on two issues: first, a description of the devastating California coastal storms of 1982-83 and second, a discussion of how our coastal community must reassess risks in light of these storms.

The storms were primarily the result of the little-understood phenomena known as "El Nino". El Nino is a rare atmospheric and oceanic anomaly that is associated with the warming of ocean temperatures above the normal ranges. This warm current derives its name, the Christ child, because of its usual appearance off Peru around Christmas time. There have been eight significant El Ninos since World War II. They occur on an average of every four to five years, but irregularly.

The 1983 El Nino physically was the longest and most intense in recorded history. When it arrived it was awesome. Repercussions were felt throughout the world. It spread a swath of devastation, floods, fires, and starvation that left more than 1,100 dead, damage estimated at $8.7 billion, and human suffering beyond comprehension.

El Nino caused major climatic changes in three areas--temperature, pressure and current.

1. The temperature of the eastern equatorial Pacific Ocean was unusually warm and for a longer than normal period of time. Warmer than normal water covered the entire eastern equatorial Pacific Ocean. Instead of lasting 1-2 weeks as it has in the past, it lasted over one year.

2. There was a seesaw effect as the normal low pressure zone in the western Pacific switched places with the usual high pressure in the eastern Pacific.

3. The perennial winds and currents died and reversed direction.

Normally winds blow from east to west or from the South American coast westward toward Australia and Indonesia. This reversal in the wind patterns and warmer than normal ocean temperatures pushed ocean waters against the Pacific Coast of North and South America, and in California brought the storm from farther south than normal. These shifts brought torrential rains, winds, and high waves to the Southern California coastal region. A factor which significantly increased the destructive power of the storms was their occurrence during high tides. It happened that the highest waves during three of our storms arrived at the same time as the highest or second highest tides of the month.

In addition to all of this, the accumulated beach erosion that had resulted from previous 1982-83 storms (and there were about 7 distinguishable events from November through March) left many piers, homes, and other structures unprotected from the onslaught of the heavy breakers. Thus, damages from the March storm exceeded those of any of the other earlier storms of the 1983 winter.

The 1983 storms were far more harmful to our coast than storms we have known in the past 30 to 40 years. Although we probably will never be able to prepare completely for major events such as those we experienced, it's easy to see how attitudes can become relaxed during a time of unusually calm weather.

There simply was not time to repair the beaches after the January storm, and so the protection they might normally have afforded was gone when the even more severe storm came in March. Beaches along Los Angeles County eroded an estimated 50-100' inland.

Every coastal county in California experienced damage as a result of these storms. Total damages to coastal areas are estimated at $115 million.

Southern California's piers also provide an example of how structures were attacked by these waves. While pilings are always being pounded by storms, the waves don't normally reach the decking, but they did in 1983. Damage to decking weakened the overall pier structure, causing reinforced concrete to fall.

The effect of the storms on the 80-year-old breakwater at Los Angeles Harbor sums up the experience at many harbors along the coast. The breakwater, constructed over a 14 year period, from 1899 to 1912, had never suffered major damages before this series of storms. Built pyramid-like out of rectangular granite, with capstones weighing 10 to 20 tons, only minor repairs have been required in the past--such as single capstone replacement. In the January storm the breakwater held, although there were some damages. The March storm, however, did severe damage. The breakwater held for the first day, but finally sustained damages when the wave heights reached 15 to 25 feet, considerably above the design wave of 17 to 19 feet that is currently used for harbors on the Southern California coast. The result was the creation of a 350-foot gap in the middle of the breakwater and several small gaps 40 to 50 feet wide.

While damage at the LA Harbor Breakwater was most dramatic, publicly maintained harbors required repairs totalling $25 million. In overview, the storms of 1982-83 devastated many coastal facilities, both public and private. Clearly, the risks of serious storm damage were far greater than we realized and for which we were prepared. The challenge for the future will be to revise our attitudes about risk and adjust our efforts accordingly.

Just looking at the history of development along our coast may help us to understand attitudes about risk in our local coastal communities which have developed over time. As long as sea bluffs and coastal areas were left undeveloped, erosion did not present major economic or public safety problems. However, the pressures of land speculation and development at the ocean's edge and along the bluffs have encouraged people to build more densely. As this process has accelerated over the past two decades, expensive residential structures have been built in high-risk locations. Much of this construction has, in fact, taken place during the last thirty years--years which until 1982 have been unusually mild. Clearly, the storms of 1983 were so much more severe than other storms in recent history, they tested the coastal community's assumptions about risk.

Some of the adjustments we need to make relate directly to coastal design practices. But before we can make such adjustments we must have better coastal data. That is why the Corps of Engineers has embarked on a state-wide effort to gain a better understanding of what specifically makes our shoreline change, and how human activities influence those changes--that effort is known as our Coast of California Storm and Tidal Wave Study. Hopefully this effort will be a model for similar studies throughout the United States. From this type of data perhaps we can do a better job of articulating risks.

We know that these storms were rare events, but just how rare, we can't say. Some oceanographers and meterologists suggest that our good weather of the past 40 years is not going to be repeated. They predict worse storms, and more extreme high tides during storm seasons in the next ten years. Larger waves may be expected in future storms, and Pacific hurricanes may again reach the California coast as they have in the distant past.

A second adjustment which can be made is to discourage irresponsible and dangerous coastal building practices. We know that even some of the newest and best-designed structures suffered damages during the storms, but many structures built dangerously close to the water were completely destroyed. With proper education of our coastal community, we can minimize construction of unsafe structures by those who do not comprehend the risks of building along the coast. By making an effort to educate our coastal community through conferences such as this, we can encourage an awareness of the risks.

Ideas about risk are attitudes. The severity of these storms requires attitude adjustments--we must learn from our mistakes. In this way we can adjust our agency and public attitudes. While our agency's attitudes about risks may be significantly more conservative, our actions are guided by our responsibility to protect the significant economic benefits associated with a safe and secure coast.

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PHYSICAL CONSTRAINTS AND HAZARDS VERSUS COASTAL RESOURCE USE AND DEVELOPMENT

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I - Introduction

The theme of the meeting concerns the risks that are inherent in coastal resource use. This paper focusses particularly on a number of risk-related problems in the U.K., and elsewhere, with reference to several recent hazard situations.

In a forthcoming book on coastal zone management (Jolliffe & Patman, 1985), it is argued that coastal resource use and development are influenced by a broad array of physical constraints that serve to prevent certain activities and inhibit the levels of others. In the more extreme cases, use is severely inhibited because of the risks (or hazards) involved. Physical constraints are either imposed by the natural environment or represent deliberately-earned risks emanating from man's activities. Thus, for example, the 'normal' erosion anticipated from storm wave action may be exacerbated by ill-conceived coast protection works. In general, risk levels have increased, and will continue to increase, if only because of man's increased presence in a generally dynamic environment - for with the rapid and often uncontrolled, expansion of coastal zone activities, there are often too many people in the wrong place at the wrong time!

In Britain, before enactment of the 1947 Town & Country Planning Act, coastal zone development had already spread rapidly beyond the fringes of the traditional resort areas. The nature of the demands then being made on the coastal zone, and the principal factors that led to this expansionist activity, are generally well-known and need no discussion here. However, from a risk standpoint, it is important to emphasise that many constructional developments, people and their activities now occupy risk zones, some (as in the case of some U.S. East Coast barrier islands) in high-risk situations. Coastal zone planners and managers, faced with this dilemma, need sensible, operable guidelines; it is timely for them to heed the sometimes painful lessons learned by their predecessors, and from the on-going experience of other maritime countries.

II - Some of the Kinds of Physical Constraints and Hazards that have to be Managed

A broad array of physical constraints both emanate from, and in turn affect the whole of, the coastal zone. Problems of coastal zone definition left aside, it is convenient here to make a simple tripartite division of the coastal zone into the hinterland, littoral and offshore zones. Within each of these three zones, one can distinguish between so-called endogenous or 'locally imposed' and exogenous or 'externally imposed', constraints - or what some geomorphologists describe as systematic variability components (SVCs) and asystematic variability components (AVCs). It raises the question of planning scale, since it is rare that the 'boundaries' of geomorphological systems closely conform to existing administrative boundaries. Thus, the deafforested catchment basin, the upstream barrage, the along-coast marina, or the offshore dredging operation may all have serious (hazard related) ramifications for a given administrative area at the coast; environmental impacts may be imposed from distance, and temporal delays may complicate a given situation. Then it is a strong case for bringing formal and functional systems more into line.

A core issue is that of magnitude, frequency and duration. A continuously-running tide race imposes fairly predictable controls on coastal zone resource use; the sporadic hurricane poses greater problems; while the comparatively short-lived effects of a single substantial oil spill will be seriously compounded by a close-running series of substantial oil spills in the same area. Magnitude, frequency and duration combine to produce a multiplicity of environmental situations.

Littoral zones characterised by fast-running tides or frequent rip-currents are largely self-deterministic in respect of the resource uses they permit. But what of the stretch of coastline that experiences only occasional serious storm surges and consequent flooding? To what extent does one sterilise coastal resource use, or create a moratorium on further development along that coastline? What precise part does (or should) the magnitude, duration and frequency factors in hazard situations play in coastal zone planning and management?

What kind of physical constraints operate? In general terms, these are comprised of:- aspects of river regime (particularly river levels and fluvial flow conditions); the nature of coastal land strip topography, geology and substrate conditions; sea level fluctuations including sea surface geometry and motion; nearshore and offshore flow conditions; sea-floor topography and substrate conditions; coastal pollution; and scenic quality (an aesthetic factor). The activities of Man, and their environmental impact, are highly relevant also. Such constraints and hazards may operate independently, and on other occasions in conjunction as when storm-wave activity is superimposed on abnormally high water levels. Some operate continuously; others, and often the most damaging, occur only very sporadically.

Below are a random selection of typical coastal zone constraints. In the <u>hinterland zone</u>, many areas are affected by occasional river flooding. At Christchurch in New Zealand, for example, the Heathcote and Avon Rivers have subjected the city to serious flooding during periods of prolonged heavy rainfall or high spring tides. Unstable substrates may present difficult, expensive and sometimes intractable foundation problems; in the case of a sand dune area near Dunkirk in northern France, a new steelworks called for special adjustable jacks, which were deemed to be justified on the grounds of the general importance of the project.

In the littoral zone, problems of coastal erosion abound, ranging from small scale weathering losses to major losses of coastal land. Erosion may be highly beneficial in terms of coastal sediment budget and the feed-back processes that operate to remove storm wave energy. The problem arises with man's presence in erosion-liable areas, with resultant loss of valuable land and the threat to buildings, highways and even human life. The nature of the beach surface and substrate may both favour and inhibit resource use: steep, loose gravel beaches may render boat-launching extremely difficult, yet greatly favour shore fishing. Gently-sloping firm sand beaches may (in macro-tidal areas) greatly inhibit reasonable water-space use at low tide, yet afford excellent areas for sand-yacht racing, etc.

Littoral zone pollution, somewhat ironically, tends to be most constraining at peak tourist times; however,for the tourists themselves it is usually a question of 'ignorance is bliss', since people bathing in sewage-contaminated water are usually unaware of the risks of contracting hepatitis, gastro-enteritis, etc. Sterilisation of beach/water space resources is increasingly commonplace, such as the recent closure of some of the Metro Toronto public bathing beaches on the northern shore of Lake Ontario. In the summer of 1984, the government in Lisbon, Portugal, had cause to seek to impose a ban on beach use at Estoril.

Offshore zone constraints stem very much from the fact that this is a naturally hostile environment capable of wrecking all of man's structural efforts. Man's very presence in the offshore zone involves an element of risk; in Britain, statistics suggest that offshore divers are at greater risk than miners working underground. In high-activity zones like the Dover Straits or the Malacca Strait, risk-levels, e.g. because of ship collisions or groundings, increase significantly. Accidents at sea may arise from fairly subtle circumstances, such as the settling en-route of bulk cargoes like sand and gravel, or because of centre-of-gravity shifts as lobster-pots are filled onboard. Such risks involve virtually every laden voyage; in contrast, risks to water-space users in the Bay of Genoa, Italy, in July 1984 due to thousands of poisonous jellyfish was unpredictable and a fairly rare occurrence. On the other hand, in the Gulf of Mexico, at least ten categories of marine fauna are poisonous; presumably, they are there for most of the average year, pose a threat to water-space users, and focus attention on the importance of suitable 'public education' in such matters. Foundations problems are commonplace: those of rig stability on shallow substrates, and the exhumation of, and structural stresses on, undersea pipes and cables, are cases in point.

These, then, are but a very few isolated examples taken from a veritable welter of physical constraints and hazards, spatially and temporally variable in their magnitude, frequency and duration - and, for numerous coastal areas, superimposed and even misunderstood. Constraints imposed by the natural environment are increasingly being reinforced by deliberately-earned problems (that often involve risk) that stem from man-made structures and man-induced practices.

That risks are constantly being encountered and that new risks are being generated in the coastal zone has been highlighted by a flurry of quite recent events. In September 1984, Hurricane "Diana" stalked the Carolina coastline, U.S.A.; while in October 1984, Hurricane "Josephine" travelled some 200 miles out from the same coastline, fortunately tracking oceanwards; we experienced the accidental discharge of radioactive waste from the Sellafield nuclear plant, leading to water, beach and estuarine contamination and the closure of many areas to the public while governmental checks were carried out. In the English Channel, the collision of the French freighter 'Mont Louis' with a car ferry 'Olau Brittania' led to total loss of a large cargo of hexafluore uranium en-route between Canada and the Soviet Union. The potential hazards of such shipments are abundantly obvious, and extremely lethal.

III - Some of the Relationships between Constraints/Hazards and Uses of Coastal Zone

With regard to the degree of constraint on use levels, and the levels of risk involved in particular coastal zone uses, a line spectrum exists. At one end of the spectrum, probably all normal use of the coast itself is precluded - notably in high-energy zones and particularly where access to the coast from the hinterland or from seaward is extremely difficult; somewhat ironically, wildlife interests are best served in these coastal zones though the public at large benefits little from this. At the other end of the spectrum, one can argue that highly permissive environments exist, in which (in theory at least) virtually all legitimate uses of the coastal zone are possible. In between these extremes, a broad array of environmental possibilities exist, advantaging some uses here, constraining other uses there; thus presenting planners and managers with a range of options to establish optimal use patterns according to local, regional, national, and even international requirements. Whether the choice of an optimal use pattern is ever actually achieved in this spatially variable supply, and highly volatile demand, situation is quite another matter.

Because of both spatial and temporal variations in the operation of physical constraints and hazards, planners and managers are faced with a fairly limited range of 'broad' options to deal with them. Do nothing - live with the environment and take what comes? Vacate hazard zones and create a moratorium on any further development there? Remain in the hazard zone, and try to adapt to hazard situations in order to minimise the impacts?

Even more fundamental is the question whether planners 'sterilize' use of coastal zones subject to risk; or whether they 'de-sterilize' other zones (that are also subject to risk) in the face of limited resource supply or underused resources and increasing resource demands? Resource trade-offs are an important facet of risk management, e.g. the use of marginal agricultural land for trailer-parks in areas of manifest flood and erosion risk. A distinct problem arises if such trade-offs lead to substantial resource transfers, e.g. where the private sector benefits from coastal resource use and development and the public sector is disbenefitted because of, say, massive sea defence and coast protection expenditures.

A problem arises from the fact that in many maritime countries, coastal zone hazards have not been properly or fully identified and mapped. However, for many types of risk, this would raise almost insuperable difficulties anyway - such as the sporadic dispersion of radioactive waste, or the stochastic variables inherent in the conveyance of hazardous substances at sea.

IV - Some Important Aspects of Coastal Risk Management

What seem to be some of the fundamental problems in the coastal risk field? The following discussion embodies some of the principal points to emerge from a recent Economic & Social Research Council meeting (Macgill, 1983):

(1) Risks to life and property in the coastal zone call for an improved knowledge-base. In Britain, the risk research field is a relatively immature one and throws up many challenges for geomorphologists, decision-makers and others.

Physical descriptions, allied with relevant societal issues, that estimate risk are badly needed: to enable us to identify the sources of, or factors leading to, potential harm, the nature of the 'injury' it may occasion, the population at risk, the likely frequency of the hazard, any time lag, the potential for early-warning, whether the problem is increasing (fast or slow) or diminishing, and areas in which knowledge is uncertain or incomplete (Macgill, 1983).

(2) Risk perception ranges from the rational to the irrational; and often disagrees markedly with the physical specification of a risk situation. Even in cases of manifest risk, coastal users may choose to ignore warnings or simply fail to appreciate the potential risk situation. For example, it is not an uncommon occurrence for people to be stranded by a rapidly-rising tide, as happened fairly recently on the extensive mudflats of the Bristol Channel, U.K. - almost with loss of life. A perception study conducted among bluff-top property-owners at Scarborough, Ontario, revealed a generally poor appreciation of a manifestly obvious erosion threat. Absence of manifest risk, on the other hand, may be due to 'ignorance' - people at risk being blissfully unaware of the potential hazard they face. In the summer of 1984, for instance, bathers at Santa Eulalia, Ibiza, in the Mediterranean, were happily committed to a water-space grossly and obviously contaminated with only partially-treated sewage effluent! In this context, it seems that risk management is often reactive rather than anticipatory; that lack of appropriate concern is often accompanied by administrative uncertainty, apathy and complacency. We should, perhaps, be taking a more positive stance in the anticipatory approach to risk evaluation, and to the amelioration of anticipated problems.

Societal acceptance or absorption of risk is yet another 'grey area' involving such factors as risk-benefit trade-offs and compensation. In the U.K., the thorny question of compensation as a possible mechanism for ameliorating risk situations, is an idea winning increasing support - but in reality needs research into whether risks are perceived, residual, uncertain or reducible. Compensation in coastal zone matters is obviously a political minefield, but one we can't sweep under the carpet! What do you say, for instance, to a coastal landowner who offers 'selfhelp' (dumped car-bodies or rip-rap, say), is refused permission, and is then refused compensation!

(3) Public participation in risk decisions, in Britain, finds its most celebrated mechanism in the Public Inquiry - but although conspicuous, has it would seem a relatively limited applicability in the context of a full range of coastal zone issues, being restricted generally to those that come under the heading "new development to land" (Macgill, 1983). Nor does one have enormous faith in the outcome of a public inquiry; in one research study, I had occasion to analyse the papers pertaining to two beach mining inquiries and was most unimpressed by the quality of the evidence put forward by both the appellant and the antagonists, and by the reasoning that followed this evidence. Notwithstanding such reservations, public inquiries at least partially ventilate what are often highly emotive environmental issues.

(4) On information matters, there has been much criticism by antagonists in risk debates of the absence of anything approaching a 'freedom of information' act in the U.K. However, the lack of information disclosure (i.e. information that in principle is available), there is the problem of information that still has not been collected. In fact, serious gaps are evident, as appeared to be the case in the recent Sellafield incident in the U.K. when a number of thorny issues concerning the dispersion of radioactive waste were raised at public level. Acceptable assurances were slow in forthcoming. Gaps are occasionally evident in the technical assessment of a realized hazard. How the U.K. fares on the information issue in relation to other maritime countries is questionable - but without doubt, it opens up a barrel-of-worms in respect to rights, democracy, and the like!

One prescriptive goal might be the establishment of information guidelines (something along the lines of the EIA procedures, perhaps), since 'reliable and trusted information is a crucial factor in the resolution of environmental conflict' (Macgill, 1983). This argues for interagency trust, and for public trust in those agencies; Macgill contending that one point that strongly emerges from perception studies is that the lack of faith in institutions is not merely a symptom but can be an important catalyst in risk-related concerns. This appears to be true, for instance, of nuclear waste disposal in Britain. The media must take a rap-on-the-knuckles in all this, for they have on occasions blown issues up out of all reasonable proportion. Perspective in risk issues is badly needed.

One recalls the Sellafield, Cumbria, U.K., incident in November 1983, referred to above. British Nuclear Fuels Limited (BNFL) discharge radioactive waste into the Irish Sea and, as in previous years, this has given rise to the highest exposures - though levels are said to be decreasing. The problem that arose in 1983 was because "plant washings" were accidentally transferred to a sea-tank. Human error in this case has given rise to a great deal of public disquiet, notably a lack of confidence in BNFL. Thus it seems that what the nuclear community should worry about is not a lack of technical knowledge but the mistrust in which it is apparently held by large sections of the public. This mistrust has been fed by a long history of false statements by both the proponents and opponents of nuclear power (Macgill, 1983). New standards of objectivity are needed; the need to bridge the gap between so-called 'scientific arrogance' and public perception of coastal zone issues.

(5) Risk management raises the problem of the mismatch between technological development and our ability to control potentially adverse effects. Remedial measures may lag behind technological development, and be either too generous or too weak in their response. Hard evidence of the mis-match is found in near-misses and realised incidents involving the handling and transportation of hazardous substances at sea. As mentioned earlier, in the English Channel, the collision in early 1984 between the French freighter "Mont Louis" with a car ferry "Olau Brittania" led to the total loss of a cargo of packaged hexafluore uranium en-route between Canada and the Soviet Union. Despite that fact that all of the containers were eventually retrieved intact, it could have been a very different story. It rightly raises the question whether the gap between our capacity to control hazards and the magnitude of hazard problems is widening or narrowing? There is, in fact, an enormous variability between coastal zone agencies in the extent to which risk reduction opportunities are exploited and risk-benefit trade-offs are approached (Macgill, 1983).

(6) There are serious questions to be asked about our predictive capability in Britain. This problem was sorely exposed when in February 1979 serious flooding occurred at Chesilton in Dorset - and in spite of serious flooding there in December 1978. A seemingly innocuous depression in the western Atlantic tracked fairly predictably across as far as the mid-Atlantic before filling in - but not before it had bequeathed a lethal package of exceptionally long wave energy and excessive wave heights, destined in course of time to hit South Wales, virtually the whole of the south coast of England, the Channel Islands, and the coasts of Spain and Portugal. As the energy package passed each monitoring station, there was no hint that it was targetted on the Chesil Bank, Dorset, U.K., in particular; rather like an Exocet missile homing in on H.M.S. Sheffield in the Falkland Islands incident! The price we are still paying for this particular coastal hazard is high indeed.

The same could be said in September 1984 of "Hurricane Diana", blowing off the U.S. East Coast. Winds of up to 150 m.p.h. led to widespread flooding of the North Carolina coast. The British media reported that in this traumatic situation a state of emergency was called; 100,000 people were said to have moved inland as "Diana" approached, clogging state highways and turning the port city of Wilmington into a "ghost city". More importantly in a sense, it appears that the eye of the hurricane was several miles offshore 'with no sense of direction' according to the National Hurricane Center in Coral Gables, Florida. It is interesting to speculate to what extent disruption could have been reduced had predictive capability enabled "Diana's" direction to be more certainly determined.

(7) There are very real problems with respect to risk management set against economic stringency. For example, at West Bay in Dorset, U.K., one family business (representing the private sector) has, for a long period of time, profited from beach mining operations carried out on one side of the harbour. The profits are derived from the removal of a wave-sorted pea gravel that has numerous industrial applications.
The beach on the other side of

the harbour represents all mayhem - there is very little of it left, and this has had to be defended with yet another coast protection scheme. The total public investment to date, in capital and recurrent expenditure on sea defence and coast protection has been enormous. This amounts to a massive resource transfer between the public and private sector; and now at a time of economic stringency.

At the seaside resort of Weymouth, a few miles along the coast, the local authority (subsidised up to 75% of the total cost by the Department of Environment) have recently spent a figure approach £0.4M to protect one public-house and three cottages. The erosion problem has been transferred to the end of the extended seawall, where it will continue to remove land of significant amenity value!

There are also impending U-turns in risk-abatement policy. In September 1984, while "Hurricane Diana" was trying to make up its mind in the western Atlantic, considerable concern was being expressed around southern Britain about the possibility of a repeat of the disastrous coastal flooding (and accompanying erosion) caused by a tidal surge in 1953. That particular incident killed 307 people in the U.K. alone, not to mention > 30,000 animals. In September 1984, we experienced the highest (equinoctial) tides for four years, and around East Anglia tides were actually running higher than in 1953. According to "The Times", the Chief Engineer of the Anglian Water Authority was "within 15 minutes of pulling the plug and evacuating the town of Harwich". The situation is, it seems, that although the authority currently enjoy a budget of some £1.5M/yr for sea defence maintenance, they are going to need at least £5.5M/yr guaranteed for the next 20 years if the status-quo is to be maintained. In the present economic situation, this is highly unlikely - so crumbling sea defences can only face a general policy of abandonment, particularly in areas of low population density and agricultural quality. However, it would be surprising if more heavily-populated areas and higher quality agricultural land does not continue to enjoy proper protection. It is an interesting environmental sum, in an area of manifest flood and erosion risks. Somewhat ironically, the 'abandonment' strategy is much in accord with the notion of 'feeder bluffs' in areas experiencing significant erosion.

(8) A fundamental problem arises ouf of the mismatch between formal and functional systems. The coastal zone is a system that functions in its own right; the various sub-systems that make up its constitutent parts often display (in the absence of human interference) a state of dynamic equilibrium. A recurrent theme in this conference will be the fact that man is a disruptive influence, promoting short-term changes within a framework of longer term (geologic) swings-and-roundabouts. This sad mismatch between the operation of natural systems and anthropogenic impact is no better exemplified than at East Head, West Sussex. The National Trust, who own East Head sand spit, face a serious terminal scour problem at the critically thin neck of the spit - already, about one-third of this narrow portion has been lost. A total breach into Chichester Harbour would have far-reaching ramifications that would be difficult to assess but cannot reasonably be ignored. This is, in fact, a classic example of fragmented jurisdictions, blinkered local authorities a lack of suitable communication channels, and a paucity of background information. As things stand, there are four local authorities all doing their own thing, all creating erosion and flood risk for adjoining auth-

ority sectors, and barely willing (with the exception of the National Trust) to get together to discuss the problem!

Concluding Comment

It has been said that research into coastal risk management in Britain is relatively immature. This is manifest also in our risk management infrastructure. Even at the time when this paper is being despatched to the U.S. Coastal Society for inclusion in the conference proceedings, one reads in "The Sunday Times" of 18/11/84 that Britain's beaches are increasingly threatened by dangerous chemicals washed ashore. Between September 1982 and September 1983, 130 containers (that included 41 different hazardous chemicals), some of them highly dangerous, were washed up along the shores of England and Wales. The Department of Transport, which has overall responsibility for chemical cargoes, admits it has no central register. This may indicate the 'tip of the iceberg' as far as risk management in general, in Britain's coastal zone, is concerned. It needs a thorough overview as a matter of some urgency, so that coordinated and effective action can be taken.

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THE IMPORTANCE OF DATA IN COASTAL MANAGEMENT MURRELLS INLET, SOUTH CAROLINA

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Introduction

Management decisions concerning the coast require a comprehensive understanding of the coastal processes. Data from the specific coastline and general models of coastal processes are needed. This paper discusses a coastal data collection program used in the management of Murrells Inlet, South Carolina.

Murrells Inlet is a tidal inlet about 10 miles south of Myrtle Beach, SC and 80 miles northeast of Charleston, SC (Figure 1). The inlet serves private recreation craft and a small commercial fishing industry. North of the inlet is Garden City Beach, a rapidly developing coastal town with many boat docks and ramps. South of the inlet are Huntington Beach State Park and North Litchfield Beach, SC.

Congress authorized navigation improvements for Murrells Inlet in 1971 under provisions of Section 201 of the Flood Control Act of 1965. Construction began in late 1977 and was completed in 1980. Major features of the project are two jetties, a navigation channel, a weir section in the north jetty, and a sand deposition basin (Figure 2). The weir section was built at a low elevation to allow sand to pass over it into the deposition basin during periods of southerly sand transport. A dredge can periodically remove sand from the sheltered deposition basin and pump it to nearby beaches.

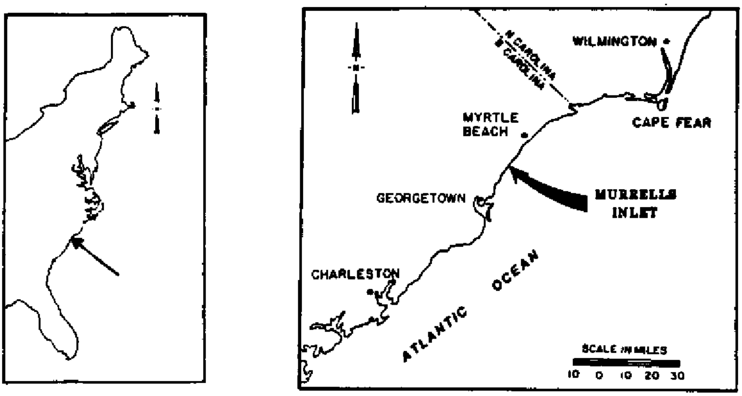

Figure 1. Location map

The jetties are over a half-mile long and are of typical rubble, quarrystone construction. The crest of the weir is at the mean water level (+2.2 MLW). The rest of the north jetty and all of the south jetty are built to an elevation of nine feet above mean low water (+9 MLW). The south jetty is capped with an asphalt recreation walkway. As part of the project, the navigation channel was dredged to a depth of -10 MLW and the deposition basin to a depth of -20 MLW. More than a million cubic yards of sand from these two dredging projects was pumped to beaches at Garden City Beach and Huntington Beach State Park. Shortly after construction began, the Corps of Engineers started monitoring the effect of the navigation project on the inlet and nearby beaches.

This paper briefly describes data collected in the monitoring program, presents some analysis of that data to form a picture of coastal processes at the inlet, and discusses the importance of this for management decisions.

The Data - The Monitoring Program

An extensive set of coastal data has been collected at Murrells Inlet under the monitoring program. The purpose of this program is twofold;

(1) to provide site-specific information for management of the Murrells Inlet project, and
(2) to provide general research data documenting coastal response to a jetty project.

Both the beach response to the new jetties and the wave climate forcing the response were measured.

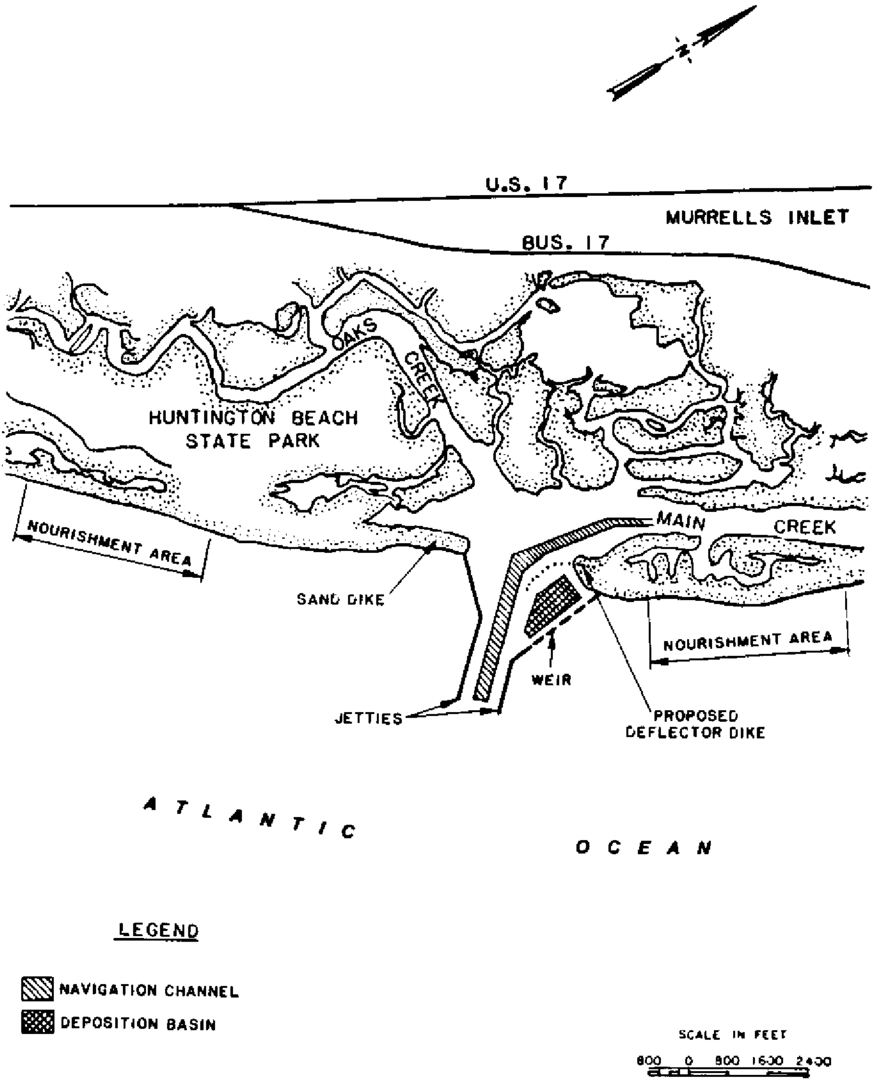

Figure 2. Murrells Inlet navigation improvement project.

Waves

Visual observations of the surf were taken daily for five years. The Corps of Engineers visual wave observation program is called LEO (Littoral Environment Observation). Daily visual observations of the wave, wind, and beach conditions are made at the same location by the same observer. Specifically, the following were estimatied daily at the four sites shown in Figure 3; breaking wave height, angle of breaking wave to shoreline, wave period, longshore current speed and direction, type of breaker, width of surf zone, beach slope, and wind speed. The four stations were set up to see the variation of the wave climate at different locations along the coast. There are limitations to the accuracy and usefulness of LEO data since it is taken visually. The primary value of LEO data lies in relative comparisons more than in absolute numbers.

Beaches

A primary goal of the Murrells Inlet monitoring program is to quantify beach response to the jetty project. The most dramatic change has been formation of a large, emerged sand bar and a lagoon on the south side of the inlet. Beach changes have been measured by beach surveying and aerial photography.

The largest part of the monitoring program is surveying of the beaches. Elevations along 43 profile lines were surveyed quarterly for the first four years after construction began. The profiles are located as shown on Figure 3 to cover much of the coastline while focusing on the inlet. In the immediate vicinity of the jetties, profiles are spaced at 500 foot intervals along the beach. Between roughly 3/4 mile and 2 miles on both sides of the jetties, profiles are spaced 1000 feet apart. Profiles continue at 5000 foot intervals to Midway Inlet to the south and beyond Kingfisher Pier to the north. Overall, the profiles cover 14 miles of coastline centered at the inlet. The profiles spaced at 500 foot intervals are aligned with the jetties. The other profiles are perpendicular to the 1977 coastline.

The landward portion of the profile is measured with level and rod at low tide in order to wade as far out on the profile as possible. The underwater portion of the profile is surveyed with a fathometer at high tide to overlap some of the beach which was surveyed by wading. The profiles are surveyed from behind the crest of the sand dunes to a depth of -18 ft MLW to cover the bulk of the active portion of the profile. Profiles far from the inlet are less than a half mile long. Some of the profiles near the inlet are almost 2 miles long.

Beach changes have also been monitored with aerial photography. Aerial photos of 14 miles of beach, centered on

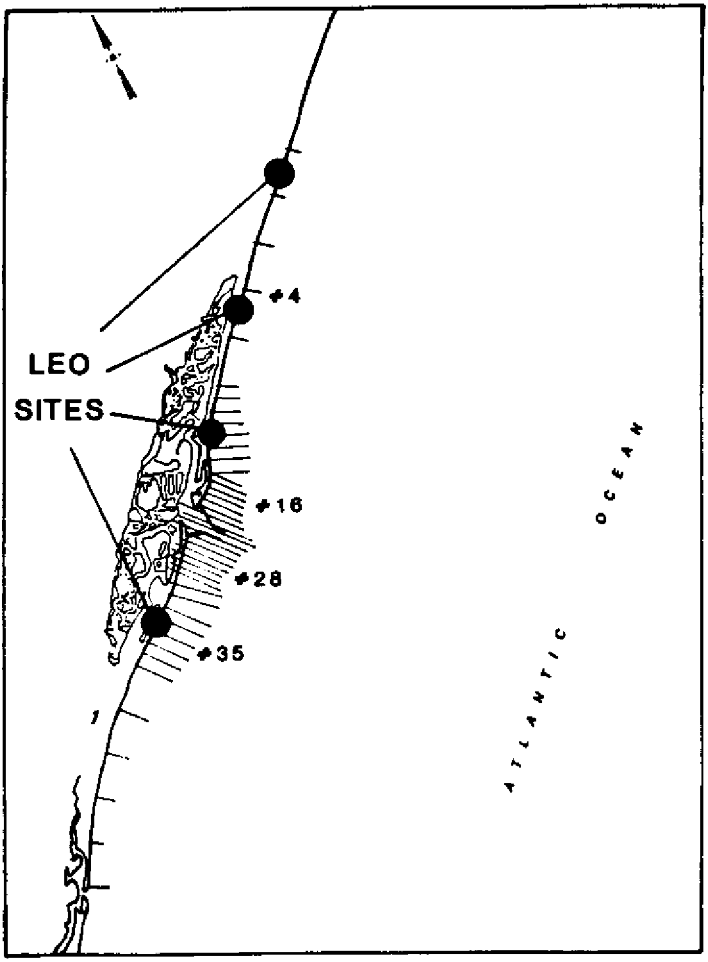

Figure 3. Location of beach profile lines and LEO sites.

the inlet, were taken monthly until October 1982, then quarterly. The flights were scheduled to coincide with low tide. The photos are an excellent qualitative history of the jetty construction and beach and inlet changes. They can also be used for quantitative analysis since ground control was included.

Inlet

The Charleston District of the Corps has closely monitored the inlet area since construction of the project. Quarterly site inspections by District engineers supplement survey trips and aerial photos. In addition to the beach profiles which include the inlet area (Figure 3), seperate surveys of the deposition basin, navigation channel, shoals, and the jetty stones have been made periodically.

What The Data Show - Analysis of the Data

Estimates of littoral drift

Longshore sand transport rates have been calculated from the LEO data. Results indicate that much sand has moved in both directions and that the net direction of transport varies with time and location. Sand transport estimates from LEO wave data are extremely sensitive to observer biases. Since different LEO observers were used, the averaging of results through time was avoided. However, trends in the direction of net transport at the four sites are clear (Figure 4). During 1979, the direction of net transport was north at all four sites. However, for 1980-1982, the direction of net transport was toward the inlet from both sides. This result could either be due to a local reversal in transport caused by the shoals and jetties at the inlet, or the inlet was a nodal point for sand transport along the South Carolina coast from 1980-1982.

Beach changes

Beach changes will be summarized considering the four profiles numbered on Figure 3. Each of these four profiles is characteristic of a stretch of the beach. Figure 5 shows the changes on each profile during the first four years of monitoring.

Profile #4 is characteristic of the beaches far away from the inlet on both sides. These beaches have not changed significantly.

Profile #16 is in the north nourishment area, the area where sand was placed during dredging of the inlet channel and deposition basin. The quarterly surveys indicate that the beaches in the nourishment area had come to a new equilibrium profile by April 1982, over a year after beach nourishment. The beach is much wider than before nourishment. It should be noted that profile #16 is close enough to the north jetty to be sheltered.

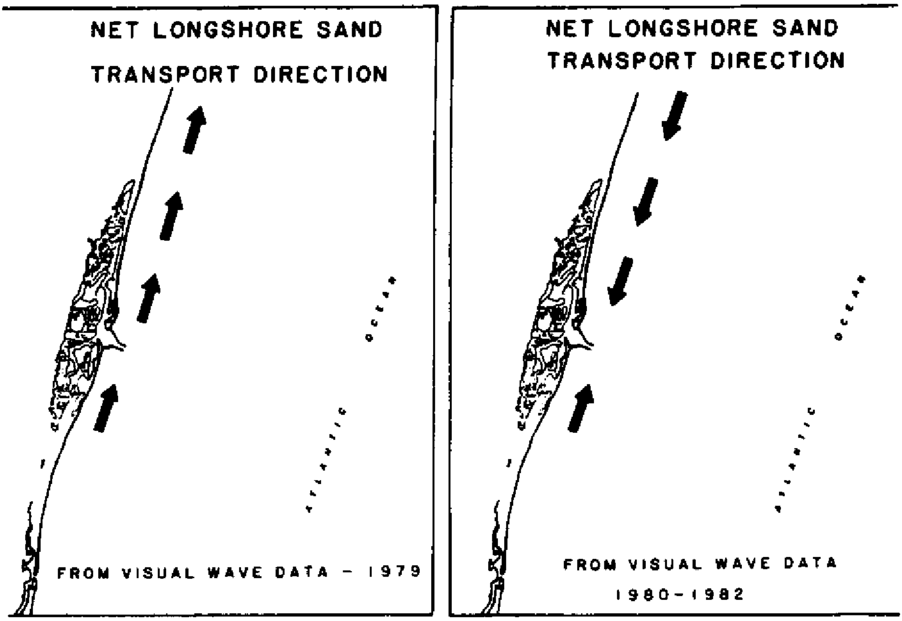

Figure 4. Net longshore sand transport direction

Profile #28 crosses the location of the old ebb-tidal shoal. Before jetty construction, a large ebb-tidal shoal was south of the tip of the present jetties. Construction of the south jetty closed the main ebb channel and directed the ebb flow out through the navigation channel. The beach profiles and aerial photos show that the sand in the shoal began moving onshore shortly thereafter. As the sand moved landward, it formed a high, shore-parallel sand bar which connected to the south jetty on the north and the state park beach a mile south of the jetty. A several acre body of water was trapped between the original beach and the emerged sand bar. This high sand bar has now become the new beach face and is several hundred feet seaward of the old beach face.

Profile #35 is in the south nourishment area. This area has behaved like the north nourishment area. After sand was placed on the beach, there was a period of profile readjustment. After about a year, the beaches had reached a new equilibrium profile. The beaches are several hundred feet wider than they were in 1977.

Between roughly three and four miles south of the jetties, a stretch of beach showed dune and beach recession.

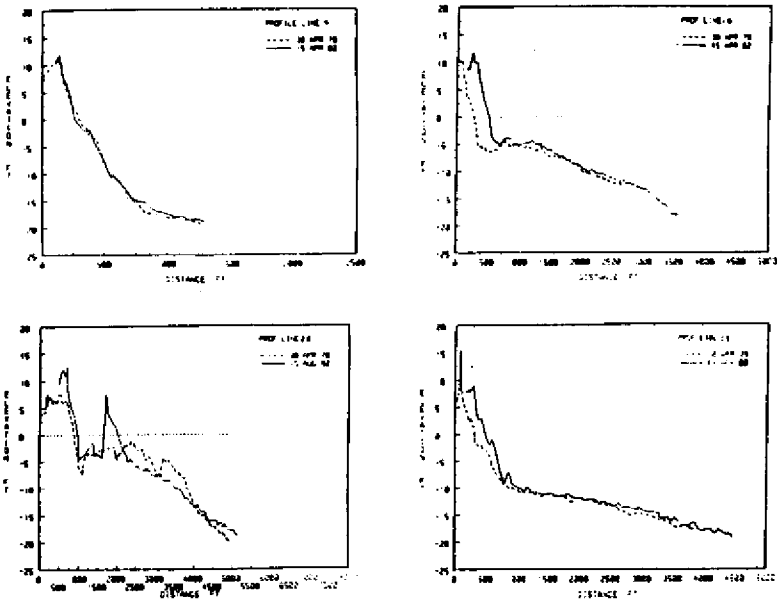

Figure 5. Beach profile changes - 4/78 to 4/82

Since profiles in this area are spaced at 5000 foot intervals, the recession only appears on one profile. Aerial photography shows that at the south end of the state park the dune and beach receded up to 50 ft. between 1978 and 1982. More recent surveys and observations indicate that this recession has stopped.

Summary of the Coastal Processes

Three processes mentioned above have combined to help nearby beaches form a new equilibrium planform with the jetties. When construction of the south jetty crossed the main ebb channel, much of the sand in the old ebb shoal moved to the state park beach. During dredging of the inlet, a million cubic yards of sand was placed on the beaches to the north and south. LEO analysis shows that much sand moved in both directions along the beach.

Aerial photos and beach surveys show that sand has filled in the angle between the south jetty and the state park beach (Figure 6). This sand fillet is common at shore-perpendicular structures. Sand which moves north into the area is trapped in the lee of the jetty when the longshore sand transport direction reverses. Such a build-up on the north jetty has been prevented by the weir. Shortly after the weir was constructed, the shoreline moved out to the beginning of the weir section and has stayed near there since.

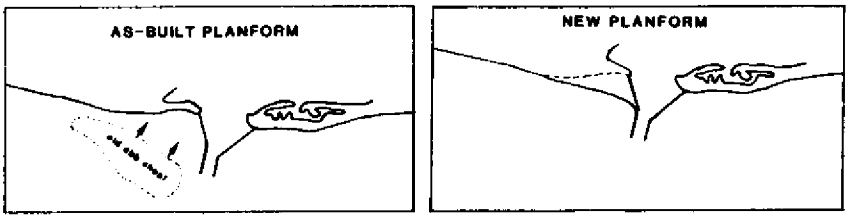

Figure 6. Schematic of beach planform change

Analysis of the coastal monitoring program data leads to an understanding of what has happened on the beaches near Murrells Inlet since jetty construction. This understanding is based on existing data and, therefore, may be modified by further analysis as more data become available. Without the monitoring program, the data base would be much smaller and the analysis much more speculative. Future political and management decisions about the Murrells Inlet area can be made with a better understanding of coastal processes of the area as a direct result of data collected in this monitoring program.

Acknowledgement

Profile survey data were collected by the U.S. Army Engineer District, Charleston. The tests described and the resulting data presented herein, unless otherwise noted, were obtained from research conducted under the Coastal Structure Evaluation and Design Program of the United States Army Corps of Engineers by the United States Army Engineer Waterways Experiment Station. Permission was granted by the Chief of Engineers to publish this information.

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ATTITUDES TOWARD HURRICANE EVACUATION IN ATLANTIC CITY, NEW JERSEY

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Abstract

When a hurricane threatens densely developed resort barrier islands, vertical evacuation is a controversial alternative to the conventional form of horizontal evacuation. In order to plan proper emergency management procedures, an understanding of the attitudes of potential users can be useful. This study has explored the extent to which residents prefer to remain on a barrier island, given a storm evacuation advisory. Atlantic City, a densely developed resort barrier island community located on the New Jersey shore, was chosen as the study site. This pilot study suggests that there are distinct groups that prefer to remain or leave a barrier island when a hurricane evacuation warning is given. The majority of those who would remain on the island chose their residence as a refuge rather than hotels or city institutions. The location of a vertical shelter in an area of perceived vulnerability, such as a beach block, may deter a resident from choosing that shelter. This may pose a problem for emergency management since casinos are located on the beach block and are the only shelters with vertical evacuation plans.

Background

When a hurricane threatens to strike a low-lying barrier island community, the area can suffer damage from high storm surge, onshore winds and coastal flooding. An informal partial evacuation off the barrier island to the mainland often occurs; a formal evacuation order may be given by emergency management personnel depending on: 1) the expected location of the hurricane; 2) maximum wind speeds; and 3) storm surge heights. Evacuation from a barrier island to the mainland during a hurricane can be difficult or impossible due to a number of emergency management problems, such as: 1) the flooding of bridges before complete evacuation can take place; and 2) traffic congestion.

An additional problem is the enhancement of hurricane warnings so as to convince residents of the hazard and possible need to evacuate (Ruch, 1981; Ruch and Christensen, 1981). A simulation of hurricane evacuation of Galveston Island, a developed barrier island on the Texas coast, showed that 30.5 hours were required for all people to leave the island during a hurricane with 120 mile per hour winds. Due to flooding in advance of the hurricane's arrival, the single bridge connecting Galveston with the mainland would be flooded 7.5 hours in advance of the hurricane's arrival (Ruch, 1981). In the coastal area of New Jersey, 24 hours are required for safe evacuation if the population at risk responds optimally (Mitchell, 1984a).

Leaving the barrier island for a safe mainland location is termed horizontal evacuation. In addition to this conventional evacuation technique, a controversial form of evacuation--termed vertical evacuation--is being seriously considered in many locations. With vertical evacuation, people seek a location on the barrier island, in buildings which would safely shelter them from storm surge, onshore winds and coastal flooding. This adjustment has been suggested as a possible alternative by Burton, Kates and White (1978), and Mitchell (1984a). An ongoing study is being conducted by Ruch (1983), in which he evaluates: 1)the structural feasibility of vertical evacuation; 2)the social and economic aspects of vertical evacuation, including the attitudes of managers and users; and 3)the legal and political aspects of vertical evacuation.

The pros and cons of vertical evacuation and the necessary infrastructures and managerial cooperation have been considered by Baker (1983, 1984). Vertical evacuation is viewed as a viable alternative for the following reasons: 1) large numbers of people would not have to leave an area as much as 300 miles wide well in advance of the hurricane's arrival; and 2) if people remain in area through vertical evacuation, the threat of predisaster looting may be diminished. Horizontal evacuation is considered prone to problems for the following reasons: 1) the intensity of a hurricane can change before its landfall so that the numbers needed to be evacuated may change; 2) there is difficulty convincing residents to leave early enough to make a conventional evacuation successful; 3) most of the residents evacuating from a 300 mile area will have left unnecessarily making them more difficult to evacuate next time; 4) the economic cost of a horizontal evacuation is enormous; 5) a horizontal evacuation increases the opportunities for traffic accidents; (Baker, 1983).

Baker (1983) has suggested the following disadvantages to vertical evacuation: 1) a building used for vertical evacuation could fail; 2) there is no way to guarantee the safety of a building despite its safe design; 3) interior walls could fail if windows fail; occupants would be subject to missiles if windows failed; 4) if more high-rise structures are built to serve as vertical shelters, the population at risk in the hazardous area will increase and conventional evacuation will become more difficult; 5) legal and equity questions such as liability for injuries, deaths and structural damages have not been answered; 6) a crowded vertical shelter might result in panic behavior. After the hurricane, the barrier island may be cut off from the mainland due to a breakdown in utilities and essential services while there are people on the island requiring medical attention.

Study Need

Because of the difficulty involved with horizontal evacuation from a barrier island, residents may prefer to remain on the island after receiving a storm evacuation advisory. If people prefer to remain on a barrier island when given a storm evacuation advisory, then vertical evacuation may be viewed by residents as a viable alternative to horizontal evacuation. The percentage of the resident population which prefers to remain on the island may indicate the potential for vertical evacuation. Cutter and Barnes (1982) examined the attitudes of evacuees following a technological hazard; an understanding of the attitudes of potential users was considered useful in order to plan proper emergency management procedures. Baker (1975) looked at the attitudes of residents toward land use policy following a hurricane. Ruch's (1983) research on vertical evacuation will include attitudes of managers and potential users. However, the preferences of potential users to hurricane evacuation have not been thoroughly examined thus far (Mitchell, 1984b).

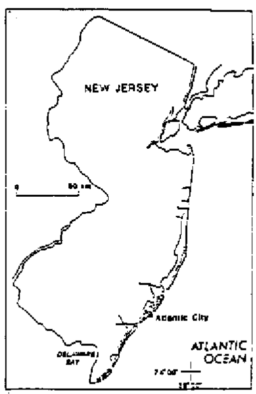
Hypothesis

This study explores the extent to which residents prefer to remain on a barrier island, upon receiving a storm evacuation advisory.

Setting

Atlantic City is a densely developed resort barrier island community located on Absecon Island on the New Jersey shore. It was chosen as the study area because it has a number of high-rise buildings which Mitchell (1984a) has suggested could be used for vertical evacuation. Atlantic County has the largest single group of potentially storm resistant high-rise buildings because of design constraints. However, only the casinos in Atlantic City have evolved formal evacuation plans. With the increased redevelopment of Atlantic City due to casino industry growth, and the problems associated with horizontal evacuation, there is an increasing need to consider alternative evacuation techniques.

Figure 1: Location Map



Methodology

Sampling Procedures

This study consisted of presenting a storm scenario and questionnaire to 39 respondents who were residents of Atlantic City or the neighboring towns of Ventnor and Margate. Eriksen (1975) summarized the advantages of a scenario methodology for natural hazards research; using scenarios permits the consideration of more than one response option to a hazard. This survey was conducted in November, 1984, which is near the end of the June-November hurricane season.

Respondents were approached at four locations in Atlantic City and Ventnor. These locations were chosen in an attempt to obtain responses from local residents rather than tourists. If the respondents indicated that they were residents of Atlantic City, Ventnor, Margate or Longport, they were asked to read a paragraph describing a storm scenario and to answer a series of questions pertaining to their behavior in response to this scenario. Residents were asked to supply the information on the spot rather than reply by mail in order to increase the response rate. At each of these four locations responses were sought for approximately one hour. In order to avoid a sampling bias, every passerby was approached where ever possible.

Data Reduction Techniques

Responses were summarized by percentage of the total sample. Evacuation responses were related to: 1) land ownership characteristics--homeowners vs. renters; 2) period of residence--seasonal vs. permanent; 3) general location of residence--closer to the beach, to the bay or to the middle of the island; and 4)experience with and memory of previous hurricanes and storms. Where residents prefer to go during a hurricane emergency and why were divided into island and mainland evacuation choices.

Results

Renters, regardless of the location of residence, people who live near the bay or in the middle of the island, and those residents who had bad experience with hurricanes preferred to remain on the island during a hurricane evacuation advisory. Homeowners, seasonal residents, people who live closest to the beach and those with no experience with hurricanes preferred to leave the island (Table 1).

Table 1: Evacuation Responses (n=39)

	% of responses	remain	leave
overall	100%	39.8	60.2
homeowners	46.2	22.2	77.8
renters	48.7	63.2	36.8
seasonal residents	20.5	12.5	87.5
permanent residents	79.5	50.0	50.0
residence located closer to			
beach	51.2	30.0	70.0
bay	33.3	61.5	38.4
middle island	15.4	57.1	42.9

	% of responses	remain	leave
no experience with hurricane	35.9	14.3	85.7
experience with hurricane	64.1	58.3	41.7
memory of '62 and '44 storms	20.5	62.5	37.5
memory of '62 storm only	30.8	58.3	41.7

Respondents were asked two questions regarding where they would go during a storm (see Appendix, questions 5 and 6). If they gave an answer to question 5, they could select the same or a different answer to question 6. The first was an open-ended question; the second sought their responses to specific options, including several vertical evacuation alternatives. As a result of this questioning format, respondents may have provided the same response more than once.

The majority of those who chose to remain on the island chose to remain at home. The majority of those who chose to leave the island indicated that they would travel to Philadelphia, 60 miles away. Approximately 30% of all respondents mentioned that they would seek refuge on high ground. Some people mentioned apartment high-rises in which they live as a vertical refuge option (Table 2).

Table 2: Where residents prefer to go during a hurricane emergency*

island	open-ended response	specific choice
residence	30.8%	33%
boardwalk	2.6	
boat	2.6	
mainland		
not specific	17.9	
within 20 miles	10.3	20.6
Philadelphia (60 miles)	23.1	33.1
would not go to Atlantic City that weekend	2.6	
vertical refuge		
% of all respondents who mentioned high ground or floor they lived on as safe refuge	30.8	
% of those who preferred to remain on island who mentioned vertical refuge	74.8	
places mentioned as vertical refuge		
high floor of residence	5.1	15.4
Convention Hall	2.6	10.3
Atlantis Hotel		5.1

*may have answered more than once.

Over 80% of the responses to remain on the island or to leave indicated a concern for personal or property safety. Safety reasons related to staying on the island included too much traffic and securing one's own property. Safety reasons related to leaving included escaping floodwaters (Table 3).

Table 3: Reasons for evacuation decision*

To stay	
safety	
ok in past	30.8%
too much traffic	2.6
to secure property	2.6
employment	2.6
to experience a hurricane	5.1
To leave	
safety	51.3%
to escape flooding	5.1
because there is an alternative	2.6

*may have answered more than once.

Discussion

The data suggest but do not confirm that there are two distinct groups, one which prefers to remain on the island and one which prefers to leave. Some respondents perceived the island and high elevations there to be safer while others perceived a mainland evacuation to be safer. Ownership may be a characteristic distinguishing these two groups. Renters preferred to remain on the island, while homeowners preferred to leave. Property and flood insurance may influence a homeowner's decision to leave his or her property although one might think that a homeowner would be inclined to stay to prevent the looting of his or her investments. Willingness to depart might also be attributed to the fact that for some of these people, the Atlantic City residences are second homes. Seasonal residents have an established alternative and therefore are more inclined to leave. Those with second homes in Atlantic City perceived themselves as having a viable alternative to remaining in the hazardous area. However, there are more year-round homeowners than seasonal residents.

Public vs. private transportation may influence evacuation decisions. Without an independent means of transportation, residents may perceive themselves as having limited evacuation options. Automobile owners may be reluctant to leave because of the traffic congestion caused by mass evacuation.

Experience with hurricanes is another characteristic distinguishing those who prefer to stay from those who prefer to leave the island. Having survived previous hurricanes may be an incentive for some residents to stay. Experience may tell them that riding out storms is possible and more desirable due to the costs of evacuating and the looting that may occur during a horizontal evacuation.

An attempt was made to address the question of vertical evacuation by giving respondents specific choices of where to go (Appendix, question 6). Half mentioned vertical evacuation in hotels and public buildings like Convention Hall; half mentioned their residences as places for vertical evacuation. The responses to this question indicated that a total of 15.4% of respondents would evacuate to Convention Hall (10.3%) or the Atlantis Hotel (5.1%) (Table 2).The majority of those who would remain on the island prefer their homes for refuge. Some of these people would use the upper floors of their homes as vertical shelters. In addition, some residents who live on high floors of multi-story buildings would remain in their apartments during a hurricane emergency. 15.4% of the total respondents or 37.5% of those who chose to stay would seek vertical refuge in their homes. 30.8% of the total sample mentioned vertical evacuation as an option; this constitutes approximately 75% of those who prefer to stay on the island. This preference for one's residence as a vertical shelter suggests that casinos may not be the preferred vertical shelter even though the casinos are the only multi-story buildings equipped with evacuation plans. Vertical evacuation may be a viable alternative, however; most respondents did not mention the casinos as shelters. Evacuation plans for the casinos are predominantly concerned with sheltering hotel guests for the duration of the emergency. Provisions for hurricane emergencies by the casinos state that their businesses will remain open until the last possible minute. It is not clear whether residents are aware of the casinos as a viable emergency shelter option.

Another factor which distinguishes those who prefer to remain from those who prefer to leave is the section of the island on which respondents live. Residents of the middle island and bay areas preferred to stay on the island. This preference may reflect their perception of diminished vulnerability to storm surge and onshore winds. Residents of beach blocks may leave because they perceive a greater vulnerability to these elements. However, most vertical shelters are located on beach blocks. The desire of beach block residents to leave may indicate that residents who remain may not feel safe enough to evacuate to beach blocks even if that is where vertical shelters are located. The presence of high-rise buildings--whether they are casinos or apartment houses--may not be sufficient to encourage the cooperation of residents in a vertical evacuation. The location of vertical shelters on the island may be significant. Emergency response planners need to consider these attitudes towards the location of vertical shelters in order to encourage the cooperation of potential users.

Where people prefer to go during a hurricane is based primarily on their perceptions of safety. While casinos and public buildings may function as vertical evacuation sites, the respondents preferred residences over these buildings as safe refuges. Only one respondent mentioned Convention Hall as an evacuation alternative in an open-ended question. This respondent was a police officer who was familiar with the City's emergency management plan.

The greatest percentage of those preferring to leave the island during a hurricane emergency (33.1%) would go to Philadelphia, which is 60 miles away. In contrast, 20.6% prefer to remain within 20 miles of Atlantic City, on the mainland. Remaining closeby may be related to their concern for their property. Residents can return to the island more quickly if they have taken refuge less than an hour away.

Future Study

Additional work on evacuation attitudes is needed before conclusive statements can be made. Methodology should be improved to address directly the question of attitudes toward vertical evacuation. This study did not ascertain thoroughly enough how the residents who prefer to remain on the island viewed vertical evacuation. It is unclear whether vertical evacuation is not a preferred alternative or whether a more effective methodology would generate a different response. A more effective methodology would also include a more systematic sampling flow, spatially and temporally, including visits to casinos (Mitchell, 1984b).

The scenario methodology was useful in securing responses to a hypothetical situation. However, it may be more useful if a series of scenarios could establish the threshold conditions which would cause potential evacuees to horizontally or vertically evacuate. A future study could address issues such as: 1) whether a preference for vertical evacuation would exist due to traffic congestion; and 2) how hurricane intensity affects preference for vertical evacuation The following factors may have influenced responses and need to be investigated further: 1) transportation, 2) flood insurance, and 3) residents' familiarity with Atlantic City's Emergency Management Plan.

Conclusions

This pilot study suggests that there are distinct groups which prefer to remain or leave a barrier island when a hurricane evacuation warning is given. Property ownership, location of residence and previous experience with hurricanes are possible parameters for these groups. Perception of safety is the primary motivating factor for those who preferred to stay as well as those who preferred to leave. The majority of those who would remain on the island chose their residence as a refuge, rather than hotels or city institutions like Convention Hall. The location of a vertical shelter in an area of perceived vulnerability, such as a beach block, may deter a resident from choosing that shelter. This may pose a problem for emergency management since casinos are located on the beach block and are the only vertical shelters with evacuation plans.

Study results do not overwhelmingly confirm the hypothesis that residents prefer to remain on the island. However the results do indicate that approximately 40% of the population prefers to remain on the island during a hurricane evacuation advisory. Therefore, vertical evacuation may be an adequately viable alternative to make it a desirable component of emergency management planning for an urbanized barrier island.

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Appendix: Questionnaire

1) Are you a resident of Atlantic City--that is a homeowner or renter?
   yes   no
2) How long have you lived here?________________________

   Read paragraph scenario.

3) Given the preceding information, would you stay on the island?
   yes   no
4) Why?____
5) Where would you go?_________________________________
6) Given the following choice, to which of these places would you prefer to go?
   remain in house
   Convention Hall (on the beach)
   Atlantis Hotel (on the beach)
   Harrah's Marina Hotel (on the bay)
   mainland closeby (within 20 miles)

mainland 60 miles away (Phila.)

7) Are you a permanent resident or a seasonal resident?

8) Is your home closer to the beach
to the bay
in the middle

9)Have you ever experienced a major storm or hurricane? yes no
When______________________________

10)Do you remember the Ash Wednesday Storm of March 1962? yes no
Do you remember the Hurricane of 1944? yes no

Misc. 11) Male Female

12) Age
18-25______
26-40______
41-60______
over 60

13) Occupation____________________

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IMPACTS OF ENERGY ACTIVITIES ON COASTAL TOURISM

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The study on the "Impacts of Energy Activities on Shorefront Recreational Resources" examines the impacts on the New Jersey shorefront economy that result from environmental changes associated with energy facility development. The two-year study, commissioned by the Department of Environmental Protection (DEP)'s Division of Coastal Resources (DCR) in 1982 and prepared by Rogers, Golden and Halpern (RGH), describes the extent to which development of energy facilities might cause tourists to seek out alternate vacation destinations.

The DCR, along with many other observers, recognized that tourism constitutes a vital part of New Jersey's economy but had no reliable measure of tourism's contribution to the coastal economy. Also, DCR recognized that although energy facilities and recreational uses of the shore can co-exist, construction and operation of an energy facility may cause a decline in tourism related to environmental impacts that result from construction or operation of an energy facility.

The study confirmed that tourism's contribution to the state's economy is significant, as shown on Table 1. Also, the study confirmed that the southern oceanfront communities are more dependent upon tourism than the more northerly communities, and barrier islands are more dependent on tourism than backbay communities.

The results of this study will be incorporated into the decision making process used by the DCR to determine the acceptability of a proposed energy facility at a particular site. The DCR uses Coastal Resource and Development Policies to evaulate all proposals to site energy facilities within the coastal zone. These policies encourage energy facilities to locate in built-up urban coastal areas, and discourage them in less developed areas of the coast. The energy use policies require the NJ Department of Energy to determine the need for an energy facility as part of the decision making process.

Table 1: Study Findings

Study results support the long time observation that coastal tourism is a vital part of the New Jersey economy[1]:

Non-business travellers spent $5 billion in the coastal region.

$850 million was spent at hotels, motels and campgrounds.

$850 million was spent on food and drink.

Casinos generated:

$1.5 billion from gambling
$250 million from eating and drinking (included above)
$109 million from room revenues (included above)

Approximately 6.7 percent of New Jersey's resident employment is supported annually by tourist expenditures

1. In 1982 dollars

Once the location and use are deemed acceptable, tourism's contribution to the local and regional economy as well as the estimate of tourism lost as a result of location of an energy facility can be examined. Local and regional benefits derived from construction and operation of an energy facility can be contrasted with tourism impacts.

The estimate of the economic importance of tourism was performed with the assistance and expertise of two subcontractors to RGH during this study. They were the United States Travel Data Center in Washington, D.C. and the Regional Science Research Institute in Amherst, Massachusetts.

Coastal Tourism Response Model

The Coastal Tourism Response Model (CTRM) is designed to estimate the two major types of economic impacts that accompany the construction and operation of energy facilities. These are 1) the employment, income and fiscal impacts of the energy facility construction and operation, and 2) the employment and income impacts on the tourism industry produced by the direct environmental impacts that accompany a facility's construction and operation. The magnitude and composition of the economic effects are estimated for both impact types. The model estimates impacts at three levels: the affected municipality, the study area (Atlantic, Cape May, Monmouth and Ocean Counties) and the state.

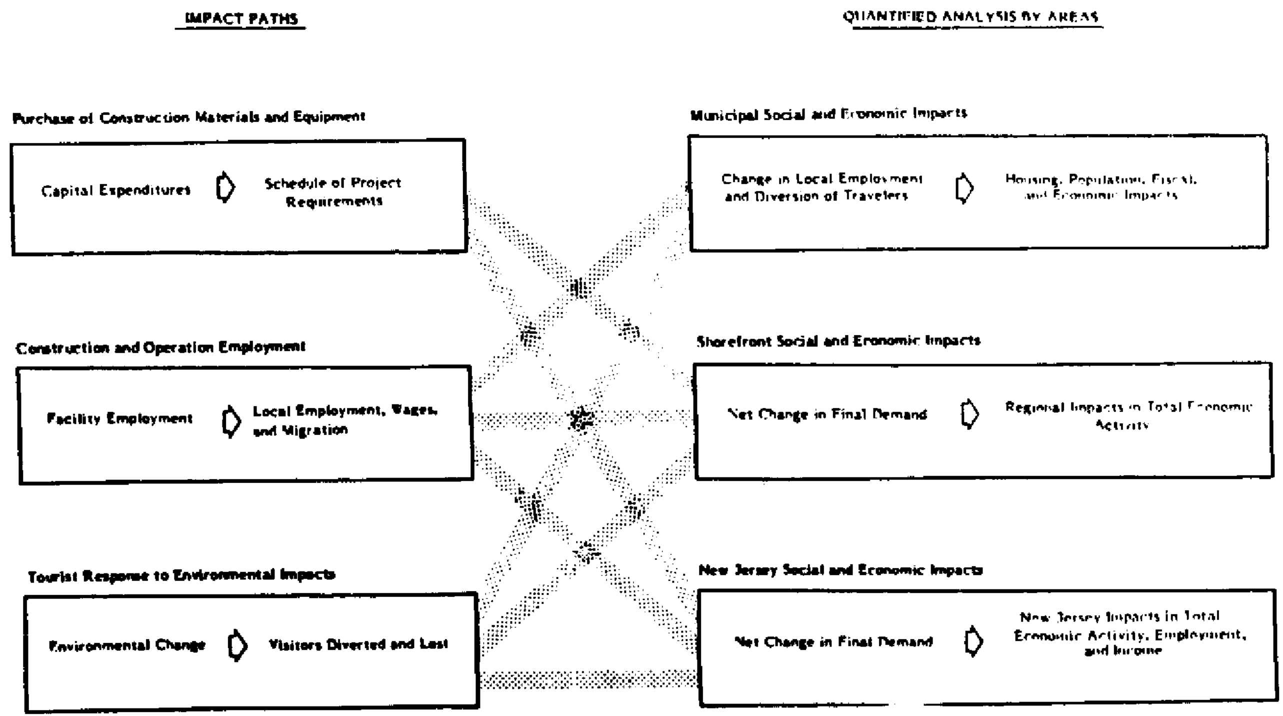
Figure 1 presents a schematic of the relationships between the six major components that comprise the model. It indicates clearly the three impact paths and the three levels of analysis. The first two impact paths constitute a standard approach to estimating the total regional economic impacts produced by the development of a major facility. In Impact Path 3, an assessment is made of a negative aspect of energy facility development, loss of tourism.

The first step in the impact path procedure is to itemize the environmental impacts that the energy facilities will have in the municipalities where they would most likely be sited. These impacts are then considered in tandem with data on tourism within each municipality and the percent change in tourism that could be expected from the environmental change. By structuring the analysis around twenty classes of visitor types comprised of five accommodation types (seasonal home, hotel or motel, campground, home of friend or day party), four principal activities (shorefront recreation, bay water recreation, entertainment and visiting friends) six kinds of environmental change and six tourism sub-regions, the model yields detailed estimates of change in the level of tourism.

The first step in determining tourist response to energy facility development is to consider the development activities that occur at an energy facility site. Examples of such activities are surface grading during site preparation, shoring during construction, and liquid waste disposal during facility operation. There are fifteen matrices, one for each energy facility type.

The mere presence of direct change in the natural and manmade environments will not necessarily generate adverse tourist response. Rather, it is the change that is perceived by tourists that causes them to carry out their recreational activities elsewhere.

Figure 1 Coastal Tourism Response Model: Computer-Assisted Model Components



The next step in the analysis is to classify direct change categories into those types which can be perceived and could generate an adverse response, and those which would not. The emphasis here is on which changes are perceived by tourists to deplete or diminish the amount or quality of recreational resources they are currently using. A decrease in recreational resource quality can mean a direct impact, such as oil spill on a beach, or a potential impact, such as the introduction of hazardous materials in an area where their unplanned release could endanger human health. There are six main categories of perceived losses in the quality of recreational resources that can cause adverse tourist reaction.

Given an environmental change caused by a particular type of energy facility, there are three response alternatives open to tourists in the area. During the first year of a permanent or temporary change, visitors may simply decide to stay, they may be diverted from the affected area to another shorefront municipality, or they may be diverted from the entire shorefront region and seek another recreational resource. These three alternatives are repeated in subsequent years.

Visitor Response Coefficients and Return Rates

Coastal tourism response coefficients were estimated for each of the combinations of visitor group types, environmental changes and tourism sub-regions. These response coefficients represent the percentage of visitors within each group type that would be diverted from an area experiencing an environmental change.

In order to make reasonably accurate calculations of tourism loss using the model, a group of fifteen experts knowledgeable about the social and economic activity along the New Jersey shore were assembled to aid in the estimation process. Together, the fifteen brought considerable experience in a variety of disciplines to bear on a series of hypothetical situations. The experts represented both public and private interests. This workshop was held at Stockton State College in Pomona, New Jersey on November 22, 1982.

Case Study

At this point it is useful to compare the impact of the same facility in different locations to determine to what degree the selected facility location can alter the effect on environmental resources and hence on tourism. In this case, an identical coal fired plant was tested in Lacey Township, located in the northern, more developed, part of the coast, and in Upper Township, located further south, in a less developed section of the coast.

The model was run using information from the New Jersey Central Power and Light Company (JCPL) about a 600 megawatt power plant that they are considering. JCP&L is engaged in a planning study to determine if additional coal-fired generating capacity is required. One of the four sites included in this study is immediately adjacent to the Forked River nuclear power plant in Lacey Township, Ocean County.

The model was run assuming that the plant would be located at the Forked River site. Two alternatives were considered at this location: 1) the base plan which assumes that coal arrives by rail, and 2) the alternate plan which assumes that the coal arrives by barge. Under this latter design, the coal barges would cross Barnegat Bay and unload at a facility located on the edge of Barnegat Bay. The latter scenario assumed that the movement of the barges would also have an effect on Ocean Township and Barnegat Light Borough. Thus, the alternate scenario considered the potential impacts on tourism in three municipalities, while in the base case, only impacts on Lacey Township were considered.

The model was also run for a third case, in which the base plant was located in Cape May County. This was done to determine the potential differential impacts on tourism between a location in Ocean County and one in Cape May County.

The outputs from the model runs are presented in Table 2. As expected the number of tourists diverted out of the affected municipalities is larger under case 2 than 1. A similar pattern holds for tourism final demand loss. Gross economic output is just slightly higher under case 2 than case 1. In this instance, the slightly higher capital cost of the second option (e.g. coal shipment by barge) is dampened by the higher tourism losses.

One interesting result is that for the second case study the changes for the first two variables increase from the peak construction year to the second operating year. This is attributable to the fact that the operation of coal barges in Barnegat Bay would have significant adverse impacts on tourism once the plant begins operation.

As expected, the impacts on tourism would be higher in Upper Township. This area has a large number of campsites and other recreational visitors that would be diverted by the development of a power plant. The lower change in shorefront study area gross economic output under the third case during peak construction results from a combination of higher tourism losses, and a larger proportion of direct labor and material inputs obtained outside of the study area.

Conclusions and Further Research

Based on the results of these and other model runs, a few general findings emerge:

1. Large facilities have positive net regional economic benefits, even taking into consideration adverse impacts on tourism.

2. Small facilities located in tourist dependent areas (i.e. Cape May County) can generate small positive or even negative net economic impacts at the regional and state levels. The adverse impacts on shorefront visitor types with high expenditures per visitor day (i.e. hotel and motel visitors) have a proportionally larger impact on the relatively low employment and income benefits accompanying facility development.

3. The proximity of the shorefront to New York and Philadelphia means that there will be minimal net permanent in-migration to the study area during the construction of large facilities.

4. The number of visitors to shorefront municipalities tends to be the primary factor in determining the magnitude of economic loss to the municipality from the diversion of tourists.

Table 2. Case Study Results

	Case Study #: 1	2	3
Total # of Tourists Diverted Out of Affected Municipality			
Peak Construction	239,104	273,372	420,209
2nd Operating Year	217,552	328,959	385,083
Tourism Final Demand Loss from Affected Municipalities-			
Peak	$8,694,000	$9,605,000	$16,700,000
2nd Operating Year	$7,842,000	$11,762,000	$15,182,000
From Shorefront Study Area-			
Peak	$918,000	$1,048,000	$1,831,000
2nd Operating Year	$811,000	$1,163,000	$1,623,000
Change in Shorefront Study Area Gross Output			
Peak	$96,476,000	$97,546,000	$93,397,000
2nd Operating Year	$13,466,000	$12,088,000	$10,771,000

5. Other things being equal, impacts of energy facility development on the tourism economy will be more severe in the southern part of the study area than in the north.

These results support one of DCR's eight basic coastal policies to concentrate rather than disperse all development, including energy facilities and to encourage the preservation of open space. The results of this study, which seem to indicate that location of energy facilities in more built up areas would have a lesser impact on tourism, is further defense of this policy.

If tourist perception does change more quickly over time than was assumed for the purpose of this model, long term impacts may be over estimated. Further research, including a different method of surveying tourists, could result in greater or lesser impacts on tourism. Also, it is worth noting that during the construction phase in particular, an energy facility can be of great benefit to a municipality and region because of additional employment and purchase of goods. In a situation where a municipality and region clearly benefit economically from location of an energy facility, a facility may be permitted even if the impacts on tourism are negative. In such a case, the municipality will have to weigh the immediate economic benefits of location of the energy facility against the long term environmental impacts and loss of tourism.

A useful tangential effort would be to adapt the model to estimate the impacts of other types of major projects, such as large mixed use developments, in addition to its present capacity to test the impacts of energy facilities on tourism. Large residential developments may not directly cause degradation of the environment as an energy facility might, but the impact on traffic and local services could cause some tourists to choose alternate vacation spots.

Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ. Copyright by The Coastal Society 1985.

SCOTTISH BEACHES AND DUNES: A NATIONAL SURVEY FOR RECREATIONAL MANAGEMENT PURPOSES

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Introduction

From 1969 until 1981 the 647 beach, dune, machair (Ritchie, 1976) and links areas which constitute 8 per cent of the 9,500 km long coastline of Scotland were surveyed. (There are 304 mainland and 343 island complexes) In addition to the main properties such as size, location, land use, physical and ecological characteristics, access and ownership, about 70 other variables were recorded for each beach unit. Each area was mapped, using standard geomorphological mapping techniques, photographed and sediment samples taken. All this data was collated and, where practicable, reduced to numerical values that were stored and analysed by standard SPSS (1975) computer-based procedures, which permitted extraction on an individual, regional or national scale. These results are published in two reports, The Beaches of the Highlands and Islands of Scotland (1977) and the Beaches of Scotland (1984).

The general survey highlights the three major factors influencing and constraining existing recreational use, that are, in order of importance: ACCESSIBILITY, OWNERSHIP AND TENURE, AND EXISTING LAND USE. The physical and ecological nature of the beach unit is relatively unimportant in all but a few special areas, as for example where the landforms and habitats are inherently fragile and incapable of withstanding visitor pressures. In general, whereas the environmental scientist perceives wind erosion, coastline retreat, species reduction and an alteration in the stability and ecological resilience of dunes and beaches as serious constraints the visitor is almost oblivious of the natural environment other than perceiving its location as an attractive, convenient transition zone between land and sea and, in particular, between a built environment and nature. Frequently the view outwards from the coastal zone is more important than the intrinsic scenic value of dunes and beaches. There is ample proof that adverse uses like sand quarrying and tipping may not be significant deterrents if the beach area is otherwise conveniently located and accessible. Thus the crux of recreational use of dunes and beach is location and access; other factors are generally subsidiary and only exceptionally overriding as a result of their exclusive domination as for example a military base or tightly controlled private land.

Accessibility

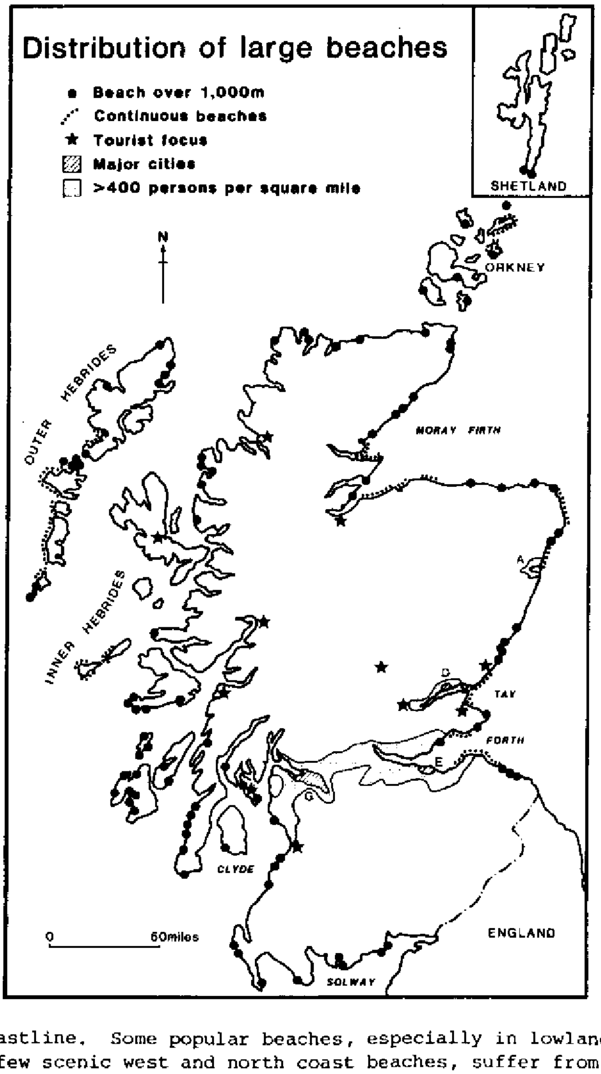
Access is the crux of beach use and management. An inaccessible beach may be prized for solitude and form a special type of recreational resource for a small number of people but as a general resource it is of little value. Conversely an accessible beach will be heavily used: it does not matter if it has some pollution problems or is scenically unattractive. Such adverse factors are only important if the area in question has local competition from other beach and dune areas. Accessibility on the national scale relates to the distribution of population which is concentrated in the central belt (Figure 1) where numerous beach areas are readily available. Many of the most attractive beaches are in the more remote Highlands and half the beaches are islands with little population. (Table 1) Thus there is an abundant provision of varied types of beaches for both native and visitor populations throughout Scotland, but there is a sharp increase in the cost of access to Highland and Island areas especially if a water crossing is required. Looking at the broad regional provision, the east coast of the mainland is better served in having many long, semi-continuous beaches but the west coast is more scenic and attractive for general tourism and holiday-making. The term "general" is significant for unlike other areas further south the use of a beach or dune area is only rarely the prime reason for a holiday visit. With the exception of specific uses such as golfing or staying at a caravan site, visitors use the beaches on a casual basis depending on weather conditions. Another significant factor is the distribution of major holiday resorts (defined on basis of accommodation usage) (Figure 1), only three of the top twelve locations are associated with or are close to recreational beaches. Thus beaches and dunes are important resources but are rarely the prime factor in the decision to visit a particular part of Scotland. Arguably, beaches and dunes are more important as amenity resources for local populations, particularly near the larger towns and in the central belt.

TABLE 1 LOCATION OF BEACH UNITS

	NUMBER	%
MAINLAND	304	47.0
ISLANDS WITH CAR FERRY	216	33.4
ISLANDS (PASSENGERS ONLY)	86	13.3
ISLANDS (NO REGULAR FERRY)	14	2.2
UNINHABITED ISLANDS	27	4.2

Accessibility must be equated with car access; 62% of beach trips are made by private car with the average round trip being of the order of 70 km (Duffield and Long, 1977). Once the beach is reached visitors do not walk far from their cars, hence local site factors are extremely important. A walking distance of 100 m or less is optimum and over 40% of Scottish beaches satisfy this criterion. Only 5% are more than 1000 m from a good road, and, if motorable tracks are considered, 70% of Scottish beaches lie within 150 m from some form of car parking. Knowledge of the existence of a beach, however, is an important factor as 40% of beaches are not visible from a road and a further 10% are only visible across lochs or other bodies of water, and 40% of beaches lie off unclassified dead-end roads. Although accessible, many beach and dune areas are

are little used unless there is a good local guidebook, map or other form of promotion.



The corollary of this information is that the provision of a car park near the beach, coupled with knowledge of its existence (eg. guidebook, leaflet or signpost) will guarantee heavy usage, especially near major accommodation centres. Conversely to close a beach it is only necessary to terminate road access about 500m away and remove the reference to it in local guide books or tourist maps.

Although access exists, many attractive dune and beach areas have limited parking facilities. Only one quarter of mainland beaches lack some form of parking nearby but the numbers that can be accommodated are often limited. Beach parking is almost unknown in all but two or three locations along the entire coastline. Some popular beaches, especially in lowland Scotland, and at a few scenic west and north coast beaches, suffer from chronic congestion when literally hundreds of visitors arrive during periods of good weather. In areas where the tourist season is short the phenomenon of swamping local communities and facilities is common and beach use congestion is only part of a wider accommodation problem.

Other barriers to access include fences, strips of cultivated land, buildings, railway lines and, rarely, notices claiming that the area is private property. These may deter visitors and reduce the level of recreational use but on the whole the population of Scotland and the many summer visitors have easy access, short travel times and a wide variety of choice. Geography has given Scotland an available tourist and amenity resource that is probably unrivalled in Europe in its freedom and east of access.

Ownership

Ownership is especially important in relation to recreational use and is closely related to management provision. At low and moderate levels of recreational use, problems of conflict of interests rarely occur. With large visitor numbers (Table 2) however the degree of interference with other uses can be considerable. Resolving these problems is difficult if the area is under multiple ownership. A large number of areas in the Highlands and Islands are under crofting tenure, often as common grazings and this brings particular problems. At present, ownership of the foreshore is of limited importance for recreational purposes. Most but not all of the Scottish foreshore is Crown Land. Problems only arise in the rare instances of beach mooring, sand extraction or industrial development. Similarly there has only been one major beach nourishment scheme (at Portobello) in Scotland. Hence legal issues related to such beach activities have rarely arisen. Contrary to public knowledge, in some areas, large parts of the Scottish foreshore are in private hands as for example along the Firth of Clyde. More important than beach ownership is the tenure of dunes and links. User groups occupy the dunes and links areas, often using the dunes for shelter, in preference to the supra-tidal beach area. Thus unlike some parts of Europe or eastern U.S.A., it is not sufficient to provide corridors whereby visitors can reach the beach via boardwalks or confined tracks. In Scotland, dunes and links are normally of equal or greater importance and used more than the beach.

TABLE 2 RECREATIONAL USE OF BEACH UNITS

NO. OF VISITORS/DAY SUMMER PEAK*	BEACH UNITS % ALL BEACHES	MAINLAND BEACHES
Under 5	29	10
5 - 25	22	16
26-100	28	33
101-500	15	28
Over 500	6	12

Excludes participants in such activities as golf

Almost half (47%) the dune and links areas of Scotland are privately owned, 12% is Local Authority, 6% state-owned (e.g. Forestry Commission) and 24% is in some form of crofting. Most of the privately owned areas are owned individually, usually as part of a farm or estate. About one quarter of privately owned land is held by companies or groups. These are mainly concerned with industrial use, sand extraction or caravan sites/ holiday villages, and are of little national significance but, at the local scale, can be of considerable importance. While not confined to company owned beaches some of the examples of difficulty of public access occur in such areas. Another subcategory or privately owned dunes and links are Golf courses (some of which are nevertheless in Local Authority ownership), and most of which are located near towns. Public access is usually possible across the golf course links or at the margins but the course normally acts as a *de facto* barrier for public access. Areas that are occupied by caravan or camping sites have the same effect and are often specifically restrictive with respect to public access to or across their land.

A sizeable and growing proportion of the beach and dune areas of Scotland is owned by local authorities. Some towns and cities developed these areas as early as the late 19th century following the Public Parks (Scotland) Act of 1878. With such ownership came developments such as the building of sea walls, promenades, garden and play areas which in a few instances eliminated the natural landforms of dunes and sandhills. In a handful of areas, rural beaches are in local authority ownership usually as a result of an active promotion of such areas for tourist purposes. Examples include Dunnet Ba- in Caithness and the crofting "beaches" of Achmelvich and Clachtoll in Sutherland. The greatest concentration of such ownership and management is in East Lothian to cater for the large local population in the greater Edinburgh catchment. The Forestry Commission, the Nature Conservancy Council and the Ministry of Defence are other forms of state ownership. State or similar ownership does not imply easy public access. Naturally, military land is restricted but in forest and conservation areas access and recreational use is normally confined to a few relatively small but attractive, well-provisioned and publicised areas within the total area. Excellent examples of such provision occur in Forestry Commission land at Tentsmuir (Fife) and Burghead Bay (Grampian). These sites exemplify, on a local scale, the facility by which an owner can direct and control recreational use by providing simple facilities and car parking space. These "honeypot" areas absorb almost all visitor pressures and the remainder of the area is thereby protected and conserved.

There are over a hundred areas of beaches and dunes in crofting counties especially in the islands. Crofting tenure may be sub-divided into croft land and common grazings, and this form of tenure is associated with some of the more fragile and scenically attractive areas. Croft land is similar to tenanted land and many crofters eg. in Arisaig-Morar, have developed caravan sites on their holdings. Recreational pressure on common grazings ie. land held in common by the community (township) and therefore akin to multiple ownership often produces persistent and intractable problems. Communal ownership tends to promote land use inertia. It is difficult to apportion the land or to resume it out of crofting tenure so that managed recreational developments can occur. Fortunately the incidence of such difficulties is low and recreational pressures are normally light. Nevertheless there are a few crofting areas, especially on the mainland where serious problems have been generated by heavy recreational pressures and related management issues.

Changes in the ownership of beach, dune and links areas occur slowly. The proportion under public ownership has increased, albeit slowly, and the trend continues. Increasing public ownership can be equated with increased management for recreation and this can take the form of a restriction of public access to a few areas where specific provisions such as car parking, toilet blocks, interpretative facilities etc. are provided. Similarly there are some private areas where the owner has taken a deliberate decision to change the emphasis of land use from agriculture to recreation, usually in the form of a caravan or camping site. In some parts of Europe the fragmentation of land holdings on the coast, often associated with holiday homes, has produced severe problems for coastal planning and management. Fragmentation of this type is fortunately almost unknown in Scotland and it may be that development-control policies of the local authorities are capable of continuing to prevent such unwelcome developments.

An interesting trend in recent years has been the growth of management agreements often on an informal basis. Agreements of this type mainly occur in the beach areas of the Central Lowlands. A typical situation would be for a private owner to allow or facilitate greater public access in return for compensation or an agreement that the local authority will maintain and clean the area or means of access. The Countryside (Scotland) Act (1967) allows for an increase in this type of agreement. While public ownership will probably remain essential around the intensively used urban or, more rarely, rural beach areas, management agreements may prove to be useful mechanisms to improve both recreational provision and management in areas of private ownership.

Land Use

With few exceptions some recreational use is made of most beach complexes in Scotland. About 10% of the Mainland beaches are little visited, averaging less than five visitors per day in summer (Table 2). The number of "unvisited beaches" rises sharply in the islands. At the other extreme 12% of Mainland beaches and 6% of all beaches have more than 500 visitors per day. Only a few beaches near large population would have visitor numbers in excess of one or two thousand. On most beach complexes recreational use of beach, dune and links areas co-exists with some other form of land use (Table 3)

TABLE 3 COEXISTING USE OF DUNES AND BEACHES

GRAZING	66%	INDUSTRY	4%
CULTIVATION	25%	MILITARY USE	3%
SAND EXTRACTION	20%		<1%

(Percentage occurrence. Sand Extraction mainly on islands)

Grazing is the most common and widespread use. The intensity of grazing varies considerably and there are also regional differences in management practice, including open grazing on crofting common land. Cattle grazing occurs on more than 60% of dune, machair (Ritchie 1976) and links areas. Sheep grazing is equally common and tends to be dominant in more remote or inaccessible machair land in the Highlands and Islands. Grazing of dunes rather than machair, links or other forms of short-grass dune pasture is less common but not unknown.

Most areas have been grazed by sheep and cattle for centuries. There are no areas even on uninhabited islands where grazing has not occurred. It is thus impossible to assess the significance of grazing on the dune environment. It is usually assumed that grazing will reduce vegetation cover and therefore surface stability. This is true when grazing is over-intensive and allowed on fragile surfaces such as hillsides or steeply sloping dunes but at lower intensities and frequencies the effects are less clear. Secondary effects are particularly important as it is clear that treading and rubbing by cattle and sheep perpetuate small blowouts or areas or bare sand by preventing revegetation. Although not considered to be part of the present day use of dunes, links and machair there were times in the past when rabbits were encouraged as an additional source of food. Unfortunately rabbit populations are now very high in some areas, especially in the Highlands and Islands, and constitute a serious threat to the stability of many dune areas. There are 45 mainland and 22 island areas with severe rabbit infestation problems.

Grazing is thus a background factor to be considered in the environmental evaluation of almost all the dune and links complexes in Scotland. Nevertheless its direct effect on recreational use is less important and there are few instances of conflict between the two forms of use. High intensities of recreational use occur in town beaches, countryside coastal parks and, as a special case, golf courses. In all these areas, grazing is either excluded or controlled by fences. At low and moderate levels of recreational use grazing and recreational use seem to produce little or no conflict except in the rare instances when visitors cross boundary fences, enclosing grazing land.

Cultivation occurs on about one-quarter of the dunes, links and machair areas but is largely confined to the landwards margins where wind blown sand provides a moderately fertile soil. Cultivation is most important in some crofting areas especially on islands such as the Uists or Tiree where cultivation occurs in strips or patches which may be rotated from year to year. Although cultivation is an important economic use of these areas, there is little or no conflict with recreational use since this takes place on the seawards fringe of the beach and dune systems.

Other land uses include sand and gravel extraction pits which may be on the beach itself or in the dunes. In general, such extraction is more common in island areas where this may be the only viable source of sand for building and related purposes. The main effect of such extraction is to introduce an area which has to be avoided by visitors for reasons of safety. There are also visual effects which detract from the general quality of the beach and dune environments. Environmental effects especially with regard to sediment budgets may be locally significant but in the short term these are not important with respect to recreational and amenity use. In the medium term, sand extraction is a threat as it is consuming the resource base and such extraction is ultimately incompatible with most other land uses, and is of particular concern since it is usually the most accessible beach units (and parts of these beach units) which are so affected. In addition, tracks to and from these extraction areas also affect adjacent links, machair and dune pasture surfaces.

Industrial use occupies about 4% of the beach complexes of Scotland and is thus on a National scale unimportant. In the few cases where it does occur, the local effects are normally severe, often excluding other users and severely reducing its amenity and scenic value. Short stretches of the coastline of the Firths of Clyde and Forth are affected by such use, usually in the form of large structures such as power plants, chemical and fertilizer plants. These cannot be readily landscaped and in a few instances there is smoke and other forms of pollution.

Military use occurs in 3% of the beach complexes of Scotland, and normally visitors are excluded but it is unusual for the entire area of beach, dune and links to be occupied for military use so that adjacent areas are normally available for public access. The effects of military land use are thus much less severe than would otherwise be assumed. Beach complexes in military use tend to occupy some of the largest units and some are of outstanding scientific interest. Firing, bombing and weapons testing are the normal forms of use, all of which are usually intermittent. There are one or two airfields but these occupy small parts of the total land available.

Commercial forestry occurs in a few localities, notably on the south shores of the Moray Firth and at Tentsmuir in Fife. Like military use, forestry is associated with large dune areas and rarely excludes recreational and other uses from the margins of the forested areas. Indeed there is positive provision of picnic sites, car parks and other recreational facilities and these are among the most heavily used dune and beach areas in Scotland. Most visitors to recreational areas within forests consider the juxtaposition of dune, forest and beach to be attractive and there are undoubted advantages in the provision of shelter.

Other minor uses that have a negative effect on the value of dunes and beaches for recreational purposes are the tipping of rubble and refuse (occurs to some degree in 20% of all beach complexes), and the presence of effluent pipes (13% of all beach complexes and 21% of mainland units, especially near urban areas). Although both practices are common the actual areas involved are small and often affect limited and clearly defined sectors of the total beach complex area. Effluent discharge is often a problem that has been inherited from last century and the situation is improving steadily. Rubble and other forms of tipping may be on the increase and in some areas there appears to be a view that it is a method of coastal protection or land reclamation and therefore desirable. These views are debatable but there can be little doubt that the visual and other effects on tourist and visitor use are adverse.

Conclusion

The survey of all the beach and dune areas in Scotland provides a detailed, comprehensive review of a valuable national resource. The totality of the survey allows valid generalisations to be made and permits national and regional average conditions to be defined. It also gives a spatial overview of the distribution and nature of the resource and allows management decisions to be taken within the context of the ideal planning principle of 'working from the whole to the part'. Many aspects of the survey were inherently quality judgements but these were inescapable. An attempt was made to give some degree of consistency of value judgement by confining the survey personnel to a very small number of experienced research workers. Although effective planning and management occurs within the local political framework of the District (there are 28 coastal Districts (including City Districts) and 3 large all-purpose Islands Authorities), the existence of national bodies such as the Countryside Commission for Scotland, which has a responsibility to promote recreational and amenity use of the countryside, provides a mechanism whereby the advantages of overview reports such as "The Beaches of Scotland" might be utilised. Nevertheless the provision of a report on the resource base is insufficient by itself and must be complemented by a similar national report on the recreational and amenity demands of both local and visiting user groups. When this is done the stage is set to provide a national policy for the better use of the rich resource that exists in the extent, variety and range of Scottish beach and dune environments.

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Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ.

LANDSAT RESOLUTION OF TIDE, WIND, AND DEPTH EFFECTS ON CHESAPEAKE BAY SURFACE TURBIDITY

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Landsat images are analyzed to investigate the causes of turbidity variations in lower Chesapeake Bay transects. The optical density data of all images, inversely related to surface turbidity, are used to produce residual turbidity profiles showing turbidity above and below average conditions. Images with similar tidal or meteorological conditions have their residual optical density data averaged to identify probable causes of above average turbidity levels.

Freshwater discharge does not directly contribute suspended sediment to Chesapeake Bay, except from the Potomac River during times of high freshwater flow. Much of the detected surface turbidity is associated with resuspension by tidal currents.

Flood currents cause higher surface turbidity along the Eastern Shore from the Bay mouth to off the Rappahannock River mouth. High ebb-related turbidity occurs north of the Rappahannock River and in the western half of Chesapeake Bay South of Wolf Trap Shoals. Currents during spring tide produce higher surface turbidity south of the Rappahannock River than currents during other portions of the lunar cycle.

Strong wind causes greater surface turbidity than low wind except when wind direction opposes tidal currents. A large fetch (20 km) parallel to wind direction results in higher surface turbidity downwind.

A correlation exists between surface turbidity and water depth. Surface turbidity is lower in deeper water due to the weaker effect of tidal and wind resuspension. Resuspension of bottom sediment affects surface turbidities in waters as deep as 40 feet.

(ABSTRACT)

Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ.

SCIENCE FOR THE NATIONAL PARKS: THE BARRIER ISLANDS SCIENTIFIC RESEARCH BIBLIOGRAPHY PROJECT

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Background to the Project

During the 1960's and 1970's, a series of National Seashores and National Recreation Areas were created by the National Park Service (NPS) along the nation's water boundaries. Unlike many of the more remote, traditional national parks, many of these newer units are adjacent to or within major urban areas and hence are subject to very heavy human use. In an effort to balance human and natural interests, the Center for Coastal and Environmental Studies (CCES), as part of its 1983 Cooperative Research Agreement with the NPS, in 1984 began an information- collecting project aimed at better resource management for the East Coast barrier island NPS units.

Purpose of the Project

For better resource management, the National Park Service needs a scientific data base. Much research of potential use to resource managers has been carried out in these parks, yet the results of this research have not been centrally located or coherently organized.

This project begins to fill the gap, by collecting published and unpublished research results from many fields of study, providing a bibliographic guide to research and a narrative history of research at each park. Eventually, recommendations for future research will be provided. As can be seen in Figure 1, six NPS units are being researched by the CCES group, and two by Morgan State University. Work on a ninth, Gulf Islands N.S., has yet to begin.

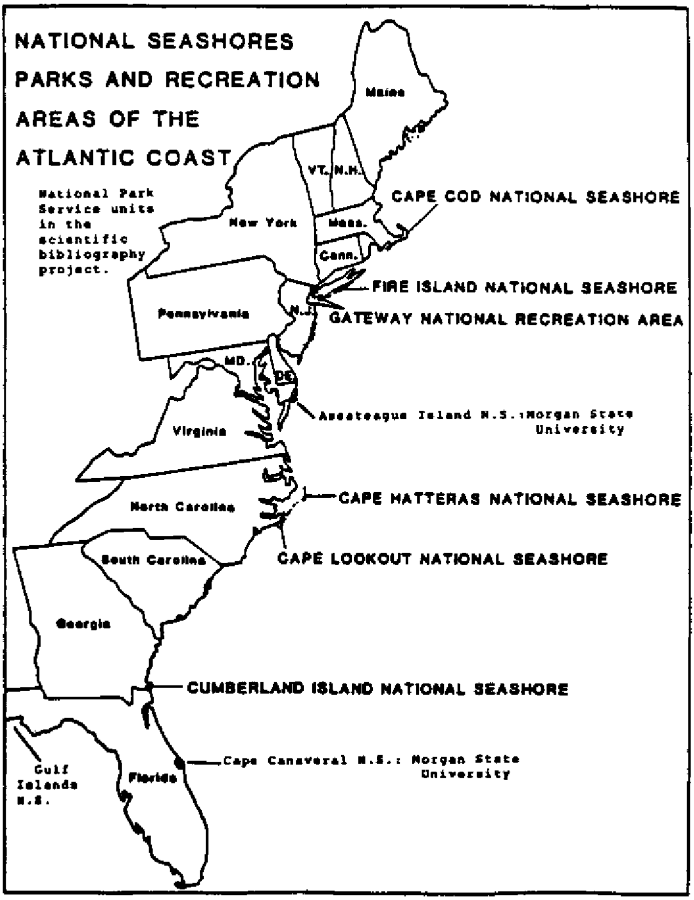

Figure 1. National Park Service units included in the Scientific Research Bibliography Project.

Methods Used

A team approach was used to review the wide-ranging literature appropriate to the six parks. Research citations were obtained from over one hundred journals, and through library research carried out at each park and at regional and national NPS offices. Helpful park personnel provided responses to several research-related questionnaires. In addition, listings of aerial photographs, maps and charts were assembled for each park.

Research citations were sorted into the following areas of research:

Birds	Coastal geomorphology
Cultural/historical	Estuarine ecology
Fishes	Geology, soils, hydrology
Insects	Reptiles
Mammals	Vegetation
Amphibians	Legislation, management, recreation and other NPS planning documents.

Products of the Project

The history and status of scientific research will be presented in three volumes for each of the six NPS parks.

Volume I: A bibliography of scientific studies

These volumes provide a listing of scientific studies, published and unpublished, in standard bibliographic form. For NPS use they will be available on IBM computer diskettes as well as paper copy. General and specific keywords are provided for retrieval purposes. CCES retains an annotated, descriptive and evaluative summary for each listed citation.

Volume II: A history of scientific research

These volumes provide, first, a narrative history of scientific research in each park, organized by the categories listed above and incorporating the most significant research citations from each Volume I. Secondly, Volume II for each park provides a comprehensive listing of ongoing scientific research, environmental monitoring, and available park research facilities.

In addition, Volume II contains a summary of maps, charts and aerial photographs available at the park and from other sources, and a listing of researchers, individuals, institutions, and agencies contacted in the compilation of this information.

Volume III: Summary, evaluation and recommendations

The third volume for each of the six parks will summarize the principal strengths and weaknesses in existing and planned scientific programs. Evaluation and recommendations will be based upon comprehensive review of the material in Volume II by authorities in each of the specialized fields being evaluated.

Conclusions

With a completion date in 1985, this project's products will provide the basic scientific information base for any researchers working on East Coast barrier islands. It is hoped that these volumes will be a tool for use both by NPS resource managers and individual scientists.

Gambling with the Shore. Proceedings of the Ninth Annual Conference of The Coastal Society. October 14-17, 1984. Atlantic City, NJ.

PROGRADATION CHARACTERISTICS OF THE CHANG JIANG (YANGTZE) RIVER DELTA

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Introduction

The Chang Jiang delta is one of the famous deltas in the world, having a total area of 51,800 km^2 (Fig. 1). The research on the Chang Jiang fluvial system has a long history and has been the focus of extensive interest. There is considerable literature on aspects of geology, geomorphology, hydrography, history, archaeology, etc., and some results have been achieved. Our efforts have concentrated on geologic and geomorphologic investigations in this region through extensive analytical work in the laboratory as well as over 500 cores collected in the field. This paper is an attempt to further probe into the developmental character and progradational model of the Chang Jiang delta.

The Chang Jiang River is 6300 km in total length. Its yearly runoff and mean sediment discharge are estimated at $924 \times 10^9 m^3$ and $486 \times 10^6 T$ respectively. The mean tidal range of its estuary is 2.6m. Due to the reduced gradient at the river mouth, the mixture of fresh water with salt water, and the widening of current and decrease of flow velocity, the river's capacity for carrying sediments is abruptly reduced and most of the sediments are dropped and deposited in the estuary, thus forming the physical basis for the development of the delta.

Characteristics of Holocene Stratigraphy

The Chang Jiang delta is situated in a region of tectonic subsidence associated with the long term depocenter so characteristic of large deltaic features. The most recent accumulations are of Holocene age and represent the latest phase of cyclic depositional events in the delta. According to lithofacies analyses of samples from boreholes in the Chang Jiang delta, the Holocene series is composed of two parts and it overlays a subaerial surface of Pleistocene Age. The surface is the paleo-valley of the Chang Jiang River. The lower portion of the Holocene unit represents the channel-filling transgressive sequence, with sandy grain

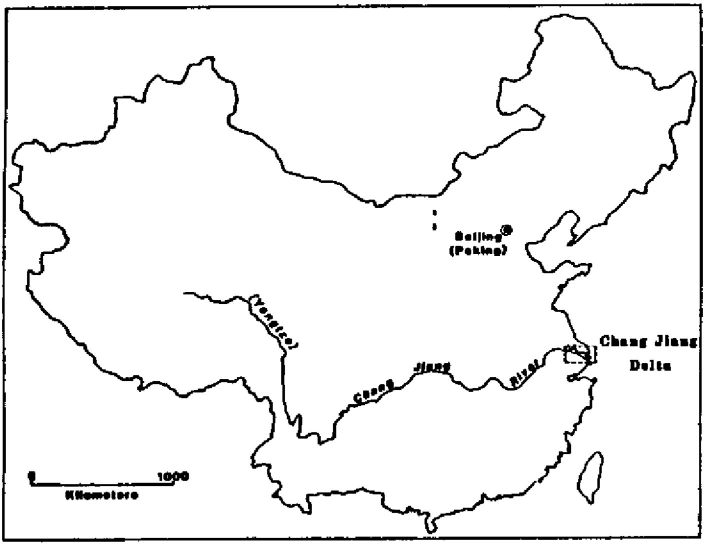

Figure 1. Study site.

size gradations fining upward, whereas the upper portion is the deltaic progradation regressive sequence, with sandy grain sizes coarsening upward. Between the upper and lower layers there is a layer of argillaceous or silty clay of prodelta, shallow marine facies. This layer exhibits a wedge-like distribution pattern, thinning westward and finally wedging out at the Hong Qiao area where the upper and lower layers of sand bodies are in direct contact and have a total thickness of over 50 m. Interpretation of the core data indicates that the paleo-bed of the Chang Jiang River toward the end of the Pleistocene may be traced out to the continental shelf of the East China Sea. The ancient Chang Jiang valley system ran across the modern deltaic area from northwest to southeast with a width of over 30 km and a depth of 50-60 m. The transgression during the Holocene Epoch advanced upstream in the paleo-valley and reached Zhengjiany-Yangzhon. Early in the Holocene the Chang Jiang estuary was an open triangularly-shaped bay widening eastward. As the transgression slowed, enormous amounts of river-borne sediments were accumulating in the estuary. Thus the deltaic sedimentary system began to develop and gradually extend seaward. The regressive deltaic bodies were deposited as the upper layer on top of the earlier transgressive fluvial/estuarine deposits.

Sedimentary Facies

Due to the variability of sedimentary environment, the sedimentary facies of the Chang Jiang estuary are very complicated (see Fig. 2). In the interaction between runoff and tidal current, runoff plays a dominant role in determing the sedimentary process and controls the regular distribution of sedimentary facies. From land to sea successively there occur delta plain facies, delta front facies and prodelta facies, which may be further subdivided into at least 13 subfacies. With the change of

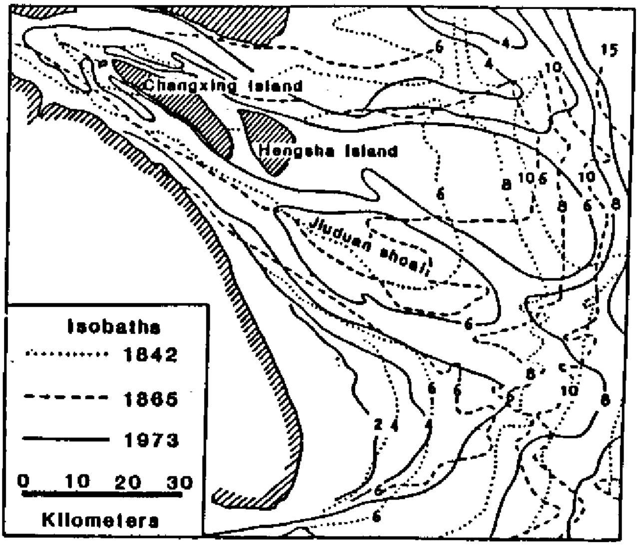

Figure 2. Underwater terrain of the Change Jiang estuary.

sedimentary environments seaward, sedimentary facies transit from one to another gradually. This is reflected in the following characteristics proceeding seaward: sediments become finer grained and more poorly-sorted; the organic content becomes higher and the shade darker; the sedimentary structures change from cross-bedding to horizontal bedding; and the marine fauna become more abundant in species with the plant debris diminishing in amount.

The associated coastal plain of the Chang Jiang delta underwent a developmental sequence similar to that of the delta proper. South of the delta, the coastal plain is composed of a barrier island-lagoonal system and is associated with fine grained accumulations. The barrier is a transgressive form in a mud-rich system. The coastal plain north of the delta contains a higher proportion of sandy accumulations. Accretionary radiating sand bars and broad tidal flat deposits characterize this zone. These materials were supplied mainly from the Chang Jiang River. However, it is suggested that tidal action is chiefly responsible for the formation of the Jianggang offshore radiating sand bar and the Qiantang estuary sand bar, a unique sedimentary model for their huge size and peculiar morphology.

Within the Chang Jiang delta there are scattered cultural relics of neolithic age and different historical periods, some of which have been dated by the C^{14} method. These are considered to be the most reliable sources for determining the ages of different subdeltas of the river. According to analyses correlating lithofacies-paleogeography with archaeological finding, the earliest delta of Holocene developed 6000 years ago. West of coastline there are a considerable number of neolithic cultural relics which have been dated in the range of 6000 years ago.

Near the coastline on the south coast, clam shells under neolithic relics and unearthed human bones from a relic site are dated at 5680 ± 180 B.P. and 5230 ± 200 B.P. respectively by C^{14}. Since that period the Chang Jiang delta has been prograding seaward stage by stage (Fig. 3).

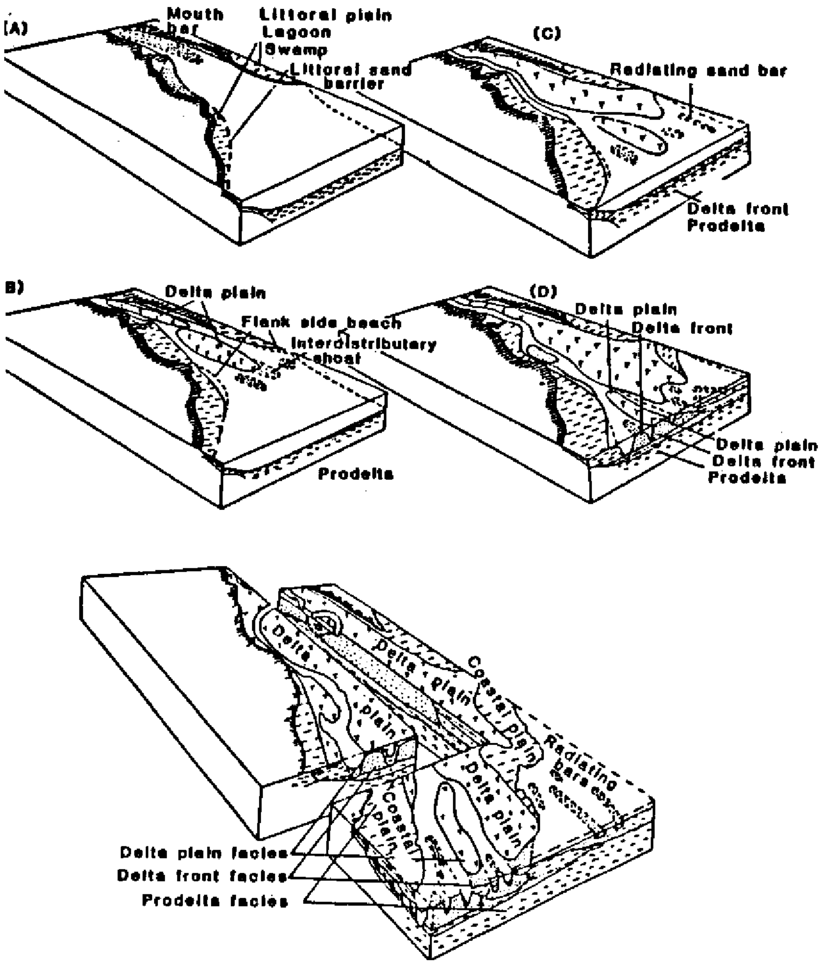

Figure 3. Model of the evolution of the Chang Jiang delta.

In more recent times, the rates of delta growth have been calculated from charts and maps. In the last decade, the average annual deposition in the estuarine zone between the isobaths -5m and -10m was estimated at about 370 x 10^6T, accounting for 76% of the total annual sediment discharge. The main portion of the delta is extending seaward at a mean annual rate of 40 m (the largest rate is at 80-90 m), whereas the coastal plain both south and north of the river is extending eastward at a mean annual rate of 8-12 m. But the mean yearly extension of southeastern corner of the coastal plain is much higher, up to 45 m during the past century.

According to a comparative study of nautical charts showing underwater terrain of the estuary in 1842, 1865 and 1973 (Fig. 2), the annual seaward shift of isobaths of 6 m, 8 m, and 10 m at the Northern Shoal between 1842 and 1865 was 60 m and 38 m and 36 m respectively, while in the area of the Jiuduan Shoal the shift was relatively limited. This suggests that in the North Passage had a higher rate of deposition than the south passage and the progradation of the former was faster. However, during the period from 1865 to 1973 the contrary was the case. The isobaths off the Northern Shoal varied little, while those off the Jiuduan Shoal shifted outward significantly. The sand bodies of the latter developed very rapidly, indicating that the development of the recent Chang Jiang delta follows its fundamental pattern of southeastly extension stage by stage.

The Basic Model of Progradation of the Delta

The above analysis of the sedimentary facies, combined with the abundant historical, archaeological and drill-hole data, indicates that the Holocene Chang Jiang delta system comprises at least six subdeltas of different stages. Each major deltaic system has a large river mouth bar as its developmental center. Each of the six Holocene subdeltas underwent initial, mature and old evolutionary stages (Fig. 3). Evidence suggests that the northern distributary mouth bar was smaller in size and relatively short-lived in age. As a result of the gradual silting up of the distributary itself, this river mouth bar ultimately attached to the northern bank of the river. In contrast, the southern one was the major discharging channel; as its mouth bar grew larger it forced the distributary to re-bifurcate into northern and southern branches. In this way, the Chang Jiang delta as a whole moved southeastward stage by stage. Thus, the mouth bars of the subdelta of various stages ranged from NW to SE in an enechelon pattern in plan and regressively overlapped one another not only in space, but also in time. The cyclicity of the deltaic development is quite clear.

The oriented development of the Chang Jiang delta proper governs the differences in progradation of associated sedimentary systems between the north and south sides of the river. The south coast has been mainly subject to the action of waves. Since the Holocene maximum transgression, there have been littoral sand barriers created at six stages and distributed parallel to this coast line extending from Jiangyin to the southeast in arc form. With the prograding of the barriers seaward by stages, the littoral plain has been continuously expanding, its constituting materials being relatively fine with mud content amounting to over 30%, the sand being in thin layers, frequently exhibiting lens-like form. Along the north coast littoral sand barriers were developed in earlier stages. When the mouth bar attached to the northern bank of the river and the delta proper shifted southeastward, the northern distributary mouth gradually was abandoned and transformed into an open bay. With the repeated action of convergence and divergence of flood and ebb tidal currents, an extensive sedimentary system of ridge-like radiating sand shoals had been formed. Subsequently they merged into the north coast plain with sand in thick layers and coarse grained, and mud content generally under 15%.

The unique model of progradation of the Chang Jiang delta is chiefly constrained by the interaction between runoff and tidal current in the Chang Jiang estuary, runoff plays a dominant part in determining the depositional process. It controls the development and evoluation of the delta, but the development of the Chang Jiang delta is characterized by its southeasterly progradation, which is evidently affected by the tidal current direction, the Coriolis effect, and the southward moving longshore current. It appears that the Chang Jiang River is different not only from the Niger and the Mekong which have only one main delta lobe, but also from the Mississippi and the Huanghi (Yellow) River whose subdeltas crisscrossed one another at random. This suggests that the Chang Jiang delta is a singular type in the world's deltaic sedimentary models.

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DEVELOPMENT OF A RESEARCH PLAN FOR A NORFOLK CANYON MARINE SANCTUARY[1]

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INTRODUCTION

The continental margin off the northeastern coast of North America from Nova Scotia to Cape Hatteras is incised by nearly 100 submarine canyons. Two of the major canyons, Oceanographer Canyon off Georges Bank and Norfolk Canyon off Chesapeake Bay are being considered for possible designation as Marine Sanctuaries under Title III of the Marine Protection Research and Sanctuaries Act (P.L. 92-532).

As part of its consideration of possible sanctuary designation, the Sanctuary Program Division, Office of Coastal Resources Management, National Oceanic and Atmospheric Administration (NOAA) commissioned two studies, one to develop an environmental description of Norfolk Canyon (EG&G, 1983) and a second to recommend a resources study plan for a possible Norfolk Canyon Marine Sanctuary (VIMS, 1985). This report presents some of the recommendations included in the resources study plan for a Norfolk Canyon Marine Sanctuary. Much of this information was developed during a Workshop on Research on Submarine Canyons held in Hampton, VA 6-7 April 1983.

Overview

The biological, geological and physical processes occurring in submarine canyons interact in such a manner that one process cannot be effectively studied in isolation from others. Meaningful research on canyons must be strongly interdisciplinary. Research in submarine canyons is also not a simple process. Extensive logistic support involving surface vessels, submersibles, remote operating vehicles and extensive "state-of-the-art" instrumentation will be required for effective and meaningful studies.

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1. Contribution 1252 from the Virginia Institute of Marine Science

Research plans for the Norfolk Canyon (or any of the other submarine canyons off the Northeastern United States) have three natural foci, biological studies, geological studies and physical (including meterological) studies. Limited pollution monitoring is also appropriate. To support these study areas and to provide information to those management agencies responsible for developing interpretation (educational), commercial and recreational development plans for a Norfolk Canyon Marine Sanctuary two additional areas of study, data and information management and socio-economic studies (involving resource use and public awareness), are necessary.

BIOLOGICAL STUDIES

While our knowledge of the biota of submarine canyons has advanced considerably over the past decade (see EG&G 1983), it is very much in a preliminary state. The major emphasis of biological research has been on the identification and inventory of large and conspicuous demersal fishes and invertebrates characteristic of particular depth strata within canyons. Efforts to address the significant processes contributing to the unique nature of canyon fauna are in their infancy. A few investigations have been conducted in recent years on biota-substrate relationships, but only a few well circumscribed benthic biotopes have received attention. Comparable investigations of biota-watermass relationships for pelagic canyon-fauna have yet to begin. Musick (1979) has described the structure of the fish communities available to otter trawls on the slope and rise near Norfolk Canyon, but studies of the fishes that live over the rugged habitats in the canyon proper are virtually non-existant.

Benthic Biological Studies

The majority of studies in the East Coast's canyons and adjacent shelf/slope regions have employed sampling gear lowered or towed from surface vessels. Such gear cannot generally be employed in structured, hard-substrate, high relief areas. Sampling has been restricted primarily to even, soft substrate low relief areas. A small number of recent investigations have used submersibles for direct observations of selected taxa. Submersible aided studies have, however, proceeded in piecemeal fashion in diverse localities and at diverse depths. The systematic use of submersibles to investigate, characterize and sample bottom communities in submarine canyons has been limited.

Three general types of research are recommended for the benthic biological area.

1. Hard substrate faunas: Initial emphasis should be given to the faunas of the presently poorly understood, hard substrate biotopes. The studies should emphasize direct observation with submersibles or remotely operated vehicles. The studies should be coordinated with geological studies and address population densities, numerical dominance, order of species, trophic relationships, species interaction, behavior patterns and substrate requirements.

2. Soft substrate faunas: Although early emphasis should be on the faunas of hard substrates, comparable studies as listed above should be conducted on the faunas of the soft substrate biotopes.

3. In-situ experimental studies: Our understanding of benthic populations and the processes that shape these populations has been markedly advanced in recent years through in-situ experimental studies in shallow waters. These studies involve a wide variety of experiments such as excluding predators with barriers, caging selected predators over specific sites, disturbing substrate and measuring recolonization rates, and conducting enclosure ("dome") studies to determine population or species respiration. Comparable studies should be conducted in canyon biotopes to investigate the ecological processes (e.g. community metabolism, predator pressure, recolonization, succession). These experiments are possible using submersibles or remotely operated vehicles to set and recover experiments.

Epi-pelagic Biological Studies

Only scant information is available concerning the relationship between submarine canyons and the pelagic species associated with the water masses interacting in the areas above the canyons. Empirical observations of both fishermen and scientists indicate that epipelagic fishes of commercial and recreational importance often concentrate immediately over the head of Norfolk Canyon. Ruzecki (1979) has described complex hydrographic processes in this region.

Two general categories of epipelagic research deserve high priority.

1. Epipelagic fish communities: A study to determine the relationships between commercial and recreational fish populations and the shelf's hydrography, meteorology and climatology should be conducted. This could be done qualitatively by examining commercial and sport fishery catch-data from the canyon in conjunction with extant environmental data from the region. Quantitative relationships would require specific surveys (particularly long lining).

2. Canyon/Shelf Plankton: Studies to identify and quantify the planktonic biota in the region of the Norfolk Canyon and compare the Canyon plankton community with the community of the adjacent shelf are also important. These studies should be closely coordinated with or contain integral hydrographic studies in the region to determine which, if any, canyon related processes are impacting the communities.

GEOLOGICAL STUDIES

Bathymetry and gross physiography of Norfolk Canyon have been detailed by Wear, Stanley and Bovis (1974) and Forde (1981). Bedrock geology in the Canyon has not been studied in detail. Comprehensive investigations of selected canyons off New England (Ryan et al, 1978) do provide a basis for interpreting much of the geology of Norfolk Canyon. Additional studies on the geology of Norfolk Canyon should concentrate initially on description of small scale geomorphological features and local sedimentary regimes of relevance to the Canyon biota.

Three categories of research should be given high priority.

1. Hard substrate: An analysis, description and characterization of the various hard substrate regimes in Norfolk Canyon should be conducted. This should be undertaken in coordination with biological studies of the hard substrate fauna.

2. Soft substrate: A comparable analysis, description and characterization of the various soft bottom substrates (and their associated biota) should also be conducted.

Both of these categories of research should initially be conducted in the shallower 100 m - 1000 m depths towards the head of the Canyon. This area is topographically and structurally more complex and biologically more heterogeneous than the lower reaches of the Canyon. Its proximity to shore and the economics involved in use of shallow versus deep submersibles make it more logical to begin intensive studies in this area and proceed systematically to greater depths.

3. Geographic and Bathymetric Mapping: A geographic and bathymetric data base of the Norfolk Canyon and adjacent shelf/slope region capable of incorporating geo-locations of specific substrate related biotopes should be developed. This data base should be coupled with a graphics system capable of generating both plane and multidimensional maps. (This project should also be considered an integral part of the Data and Information Program described later.)

PHYSICAL STUDIES

The identification and quantification of dominant length and time scales of the physical processes involved is central to understanding the movements and exchanges of water (and associated constituents such as suspended sediments, nutrients, plankton) into, out of and within Norfolk Canyon. Processes which have been hypothesized as important have temporal scales ranging from less than hourly (internal waves) to annual (seasonal heating) and incorporate aperiodic perturbations or "events" such as passage of large storms on anti-cyclonic Gulf Stream rings.

A three part program of physical studies should be given high priority.

1. Meterological studies: At least two continuing meterological stations (NOAA Data Buoys), one on the shelf and one on the slope, should be established within 50 km of Norfolk Canyon. The present fixed meterological stations closest to the Canyon (Chesapeake Light Tower near 37°N76°W and NOAA Buoy 41001 at 35°N, 73°W) are too distant from the Canyon head to provide the records necessary to understand the Canyon's circulation. Data generated from the proposed new stations can be used to develop a detailed climatology for the region and a wind profile for a study of wind forced circulation.

Additionally, a review should be made of individual ship reports used in developing SSMO's (Summary of Synoptic Meterological Observations) to determine if data points from the Norfolk Canyon or immediate vicinity are of sufficient density during different weather conditions to be useful in developing a detailed climatology.

2. <u>Hydrographic and Circulation Studies</u>: Hydrographic and circulation data from the Norfolk Canyon is quite limited. The only current measurements are those of Keller and Shephard (1978) and the only thorough hydrographic data are those of Ruzecki (1979). To remedy this lack of information, studies of circulation and water structures, internal wave and tide energy and wind forcing should be conducted. These studies will require long term records of current and temperature/salinity along the canyon axis, and hydrographic surveys (closely spaced CTD (conductivity, temperature, depth) stations) within and around the canyon to identify pycnocline strength and depth as well as meterological data.

Acquisition of this information will require moored instrumentation and extensive cruises. Hydrographic cruises could be combined with biological and geological cruises. In fact, because of the shortage of hydrographic data from the region, all research cruises should include occupation of CTD and XBT (expendable bathythermograph) stations.

3. <u>Gulf Stream-Canyon Interactions</u>: Reviews of early Experimental Frontal Analysis charts produced by the U.S. Navy and later, similar charts produced by the National Marine Fisheries Service, NOAA, indicate a tendency of anticyclonic Gulf Stream rings to migrate and remain in the vicinity of Norfolk Canyon from one to several weeks. The frequency and duration of these encounters of anticyclonic Gulf Stream rings with the Norfolk Canyon should be determined and their effect on circulation in the Canyon evaluated.

POLLUTION MONITORING

There is no evidence of pollution or potential pollution problems in the Norfolk Canyon region. There are also few data available to establish baselines for potential contaminants in the Norfolk Canyon or immediately adjacent shelf and slope sediments. An analysis of the present levels of organic and inorganic compounds in the sediments in and adjacent to the Norfolk Canyon should be made to establish a baseline. A monitoring program that would have the potential for determining trends in contaminants entering canyon's sediments should be initiated in conjunction with the other studies.

DATA AND INFORMATION MANAGEMENT

Studies of Norfolk Canyon and other submarine canyons along the east coast have been conducted by federal, state and private institutions. The data developed from these studies, much of which is in the form of underwater photographs, videotapes, or observer notes, has not been systematically collected and stored in a fashion that would allow all of the available information to be used in developing models or testing hypotheses. To remedy this lack of a central repository of information on submarine canyons, we suggest that an <u>information management system</u> be designed to incorporate the information collected in these areas and that a <u>Norfolk Canyon (or East Coast Canyon) Resource Data And Information Base</u> be established to compile, annotate and store information relevant to these areas.

We also recommend the establishment of a Norfolk Canyon Reference and Study Collection(s) and Catalog because of the paucity of specimens of the major resident taxa or geological samples from Norfolk or other east coast Canyons and the unlikely nature of large numbers of specimens being collected in the future (particularly if the region attains Marine Sanctuary status and unnecessary collection is discouraged). This activity would locate and catalog existing collections of biological and geological specimens collected from the east coast's submarine canyons in general and the Norfolk Canyon specifically. The project would arrange permanent archiving of these collections either by the present holders of the collections or by an appropriate institution.

RESOURCE USE

The principal resource uses of the Norfolk Canyon area are commercial and recreational fisheries, military training (primarily naval) and ship transit (EG&G, 1983). There is a potential interest in oil and gas exploration near the Norfolk Canyon, but present practices exclude leasing of areas in the immediate vicinity of canyons.

We suggest that the commercial and recreational fisheries of the area be quantitatively and qualitatively described. This will require surveys of participants in these fisheries since present catch statistics do not distinguish catches from the canyons. The extent of military exercises and the transit of civilian and military ships through the area should also be determined.

PUBLIC AWARENESS

Public awareness of the outer continental shelf margin in general and submarine canyons in particular is not great. Because of its depth (100m-2000m) and distance (100 km) from shore, Norfolk Canyon is not accessible for visitation. Fishermen or persons transiting in vessels do not gain a perspective of the processes or structure of the Canyon from the surface. If a Norfolk Canyon Marine Sanctuary were established, an Interpretation (Education) Plan must be developed to enhance the broadening of public knowledge of the Canyon.

The prevailing public knowledge of Norfolk Canyon (if any), and, of greater importance, what people would like to know about submarine canyons, their processes and the relationship between processes and the environment in the Canyon area should be determined. Such a survey would provide a framework in which an interpretation plan could effectively be developed.

CONCLUSION

Designation of a Norfolk Canyon Marine Sanctuary would result in an increase of both scientific and public attention being focused on the east coast's canyons in general and the Norfolk Canyon in particular.

We hope that the suggestions contained in this paper will assist in the orderly growth of research on those biological, geological and physical processes that make these areas what they are, and that the basis for future management decisions related to the canyons would, as a result, be greatly improved.

ACKNOWLEDGEMENTS

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COASTWEEK
AN IDEA: NOT AN INSTITUTION

Barbara Fegan

Coordinator
P.O. Box 545
South Wellfleet, Massachusetts 02663

The annual COASTWEEK will be celebrated October 7 through 14 from the Gulf of Maine to the Gulf of Mexico and from the shores of Massachusetts to the islands of Hawaii.

The annual celebration of the coast is unique. COASTWEEK is an idea not an institution. It is a citizen's network of groups and individuals that annually focus the attention of the country on the special place where water meets the land. Each year the number of groups and activities increases.

Each organization sponsors those activities it does best. The network groups principally focus on educational experiences. There are bird walks, beach walks, whale watchesm lectures, exhibits, forums, field trips, canoe trips, poetry and essay contests, poster and photography contests and many other innovative and exciting events. Individuals also take action.

Nationally, the Coastal Society, the Coastal States Organization, the National Audubon Society, the Coast Alliance, the Sierra Club, the National Parks and Conservation Association, the Environmental Policy Institute, the Center for Environmental Education, the League of Women Voters, the Oceanic Society, the American Littoral Society and the Friends of the Earth have endorsed COASTWEEK and urged their members to participate.

The network is guided by a small committee with no budget and no staff, which brings together and encourages the groups and individuals to do what they do best. The committee members are: Barbara Fegan of the League of Women Voters; Shirley Taylor of the Sierra Club; Carl Holcomb, Publisher of "Citizen's Update on Shoreline Policy"; and Richard Deleaney of the Coastal States Organization.

A list of suggested activities, a draft proclamation and endorsement form are available. A mailing list is maintained and a calendar of events is available.

Hundreds observed COASTWEEK '83; thousands, COASTWEEK '84 -- our goal is millions for COASTWEEK '85.

SUGGESTIONS FOR COASTWEEK ACTIVITIES

To be successful, COASTWEEK should see, at the very minimum, three things occur in each coastal state:

* Governor proclaim October 7 through 14 COASTWEEK

* Major conference on coastal issues by state office of Coastal Zone Management, Sea Grant institution or environmental organization

* Local community activities

You can make those things happen by:

* Calling or writing your governor to suggest the COASTWEEK proclamation. Suggested wording for a proclamation is included.

* Contact your state office of Coastal Zone Management and/or the nearest Sea Grant institution to suggest a conference.

* Choose your own activity from the list below. This list is not all inclusive. You will think of several things that you'd like to do. Send report form before September 15.

ACTIVITIES FOR A COMMITTEE OF ONE -- things you can do by yourself.

* Write a letter to the editor of your local paper about a coastal issue.

* Write an article for your local paper about your community's coast.

* Encourage your newspaper editor to write an editorial for COASTWEEK.

* Urge your county and/or municipal officials to proclaim October 7 through 14 COASTWEEK.

* Get out your camera this summer, take pictures of your coast. Develop a display for a local business or bank window.

ACTIVITIES FOR YOUR ORGANIZATION — you may need a committee. Talk with your leadership in June before they have completed program planning for the year.

* Encourage your organization to endorse and support COASTWEEK. Endorsement statement is included.

* Hold a meeting featuring coastal issues with an expert speaker or your own material for your membership.

* Hold a party on the beach or indoors with a water view, for fun or fundraising.

* Sponsor a community meeting on coastal issues. Program a panel, disvussion, film or speaker.

* Publish and distribute educational materials.

* Write an article for your organization's newsletter. Devote a whole issue to coastal concerns.

* Sponsor an essay, poster or photograph contest among your members.

* If your community has a Columbus Day parade, have a float or car in it.

* Sponsor beach outings such as birding, environmental hikes, etc.

ACTIVITIES, WORKING WITH OTHER GROUPS -- you may need a committee for planning and implementation or you may be the catalyst that gets the others going.

* Ask your local librarian to develop a display of coastal books or to publish an annotated bibliography of available material, books and films.

* Have a film festival at your school, college or library.

* Sponsor an essay, poster or photograph contest with your local school. Talk with the superintendent in June. Contact the science or art department. Set up the announcement of the contest in September, deadline for submission, October 2 through 8. Have the judging done by yourself, a teacher and one other person. Announce the winner(s) during COASTWEEK. You may solicit prizes from local merchants (with approval). Plan to have the winning art work made into postcards.

* Urge your local SCOUTS (Boy, Girl, Explorer or Campfire) to have a coast/beach project. It could be clean-up or an educational trip.

* Talk with your Historical Society. It could sponsor a tour of historical coastal sites, a conference on coastal history or record interviews with community residents who remember your coast in the past.

* Your nearest Natural History Museum is a natural participant. Ask them about a display and/or meeting.

* Enlist your coastal dependent industries. Ask them to develop and distribute materials about your coast.

* Encourage your local papers to run coastal articles. They are very good about getting their own material, but offer to help.

* Ask your radio stations to develop and produce programs with coastal emphasis.

* Ask your television stations to develop programs on coastal topics. Public television might do an issue series.

* Working with local environmental groups, set up tours of wetlands, tide pools, beaches, islands and other sea and lake shores.

* Talk with your local service clubs such as the JAYCEEs, Kiwanis and Rotary. Make suggestions and offer to help. Then get out of the way. If they take on the project, they'll do a great job.

COASTWEEK ACTIVITY PLAN

This report is to be mailed as soon as you have decided on what activity you or your organization will undertake. Don't wait till your plans are firm. Just report what you think you or your organization will do. The national events calendar will include your plans. DEADLINE: September 15.

Send to: COASTWEEK
Off West Road, P.O. Box 545
South Wellfleet MA 02663

PLEASE PRINT

Name ______________________ Organization ______________________

Address ______________________ City or Town ______________________

State and Zip Code ______________________ ( ) Area Phone Number ______________________

PLANNED ACTIVITY: ______________________

____

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____

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Use additional paper if necessary.

A P R O C L A M A T I O N

WHEREAS, the ______________________ has a varied coastline of rocky shores, sandy beaches, productive estuaries and salt marshes, urban ports and small harbors, tidal flats and dozens of islands; and

WHEREAS, the coast has provided us with a rich scenic, cultural and historical heritage; and

WHEREAS, the natural resources of the coastal zone are among our most economic resources; and

WHEREAS, the marine environment is one of the most valuable resources supporting an active fishing industry; and

WHEREAS, coastal landforms, especially barrier beaches, provide significant protection from coastal storms, flooding and erosion; and

WHEREAS, we are strongly committed to the wise management of the coastline to ensure for all residents that the environmental and economic value of the coastal zone will be sustained; and

WHEREAS, the coastline is also receiving nationwide recognition during the week of October 7 through 14,

NOW, THEREFORE, ____________________________ of the ___________________________ do hereby proclaim the week of October 7 through 14 to be

COASTWEEK

and urge all citizens to take cognizance of this event and to participate fittingly in its observance.

Given this day: _____________ Signed: ____________________

Title: ____________________

S E A L

E N D O R S E M E N T

COASTWEEK

October 7 thru 14

The ______________________ endorses and supports
(name of organization)
COASTWEEK, the national celebration of our coastal resources, October 7 through 14.

This endorsement recognizes the need for all sectors to work together to assure the wise use of all resources, living and non-living.

COASTWEEK is a citizen's network of organizations and individuals who annually focus attention on the salt and fresh-water shores of our nation, during the second week of October.

Signed: ____________________ Title: ____________________

Organization: ______________________________________

Address: ______________________________________

City, State and Zip Code: ____________________________

Date: ____________________ Phone: (___) ______________
Area

Mail to: Barbara Fegan
COASTWEEK
P.O. Box 545
South Wellfleet MA 02663

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USING A GREAT LAKES CURRICULUM TO DEVELOP BASIC LEARNING SKILLS IN CHILDREN

Ellen Fisher

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Madison, Wisconsin 53706

Background

Benjamin Franklin once said that "we know not what the well is worth till it is dry." The Great Lakes, the world's largest source of surface freshwater, represents a well we can't take for granted. They provide clean drinking water, a major sport fishery and vast recreational opportunities for 60 million Americans. Yet, this priceless inland sea has been ignored in the nation's textbooks and classroom programs.

Past and present abuses threaten the long-term health and viability of the Great Lakes. The troubled state of our freshwater sea can no longer remain a headline to be dealt with only by scientists and legislators; the immediacy of the situation involves everyone's involvement. To prepare school children for this responsibility, our educational process must provide early practice in water resource management.

Thanks to financial support from The Joyce Foundation of Chicago and Wisconsin's Coastal Management Program, a three-year pilot program is underway to bring the Great Lakes into classrooms. The objectives of this project are fourfold: (1) to increase teacher awareness of the economic, historical and social value of the Great Lakes as a teaching tool; (2) to provide a curriculum guide that will enable teachers to integrate Great Lakes topics into existing studies; (3) to identify and assist local contacts in planning and designing teacher training workshops; and (4) to encourage an informal network of Great Lakes educators to exchange teaching strategies and materials.

General direction has been provided by an advisory committee composed of school teachers and administrators, Great Lakes specialists, industry representatives and curriculum developers. The project director has been responsible for securing financial support, selecting project staff and participants, designing project strategy and coordinating work efforts.

Process

Teacher involvement

Teachers from a variety of disciplines and locations have been central to this project's development. In order to design a final product and service that are practical in meeting teachers' needs, we have provided several avenues for communication between project staff and educators.

Opportunities for teachers to offer suggestions and share experiences with each other as well as project staff have taken several forms. A bimonthly newsletter keeps teachers informed of project progress, Great Lakes news and information on what other teachers are doing to adapt the curriculum to their own classroom situations. During the field-testing period, teachers from around the region were able to brainstorm ideas and compare experiences by participating in a series of monthly programs through the Educational Teleconference Network--a huge partyline system. Questionnaires, telephone calls and letters provided continuous feedback on our process as well as our product.

Four phases of project

Activities of this project can be grouped into four phases: assessment of need; curriculum development; review and evaluation; and distribution.

Assessment of need

Determining a need for Great Lakes teaching aids involved answering three questions: Are teachers interested in including the Great Lakes in their classroom activities? What would they need to help them do it? What materials already exist?

Teacher interest in including the Great Lakes in their class programs was indicated by an enthusiastic response to GLRP--a Great Lakes Resource packet designed to whet their appetites for the subject. GLRP included book and film lists, maps, fact sheets, posters, news clippings, and agency publications. The number of requests surpassed all expectation, exceeding 2,000.

To answer the question of what teachers would need to help them introduce the Great Lakes into their lesson plans, we surveyed more than 3000 teachers and librarians of public and parochial schools. For a more interactive assessment, we also posed this question at conference workshops throughout the state and region. The University of Wisconsin Sea Grant Program also surveyed classroom teachers in the Lake Superior region. Results of these efforts indicated a strong teacher interest and demand for Great Lakes teaching materials and training sessions. The desired format consisted of short activity lessons for all discplines accompanied by teacher in-service workshops.

Determining what materials already exist involved a thorough review of existing resources. This effort included a search of educational data bases and a review of commonly used classroom textbooks. Results indicated little evidence of existing Great Lakes instructional materials.

Curriculum development

Twenty-five classroom teachers and fifteen Great Lakes experts from within the Great Lakes Basin participated in a three-day working session. Participants were selected on the basis of subject area expertise, experience in curriculum design and geographic location.

The purpose of this meeting was fourfold: to identify appropriate grade levels and disciplines for Great Lakes topics; to prioritize Great Lakes information that should be included in the curriculum; to design a format that is easily integrated into school programs; and to suggest specific activity ideas.

Following this workshop, a writer was hired to convert the suggested activity ideas into a first draft of the curriculum.

Review and evaluation

The preliminary draft curriculum was reviewed by workshop participants. It was critiqued on the basis of the following criteria: (1) the activities match learning objectives and are appropriate for grade level indicated; (2) the activities provide for a range of student learning abilities; (3) background information is clearly written and adequate; and (4) the activities would be appropriate for both inland and coastal locations.

A second screening of this preliminary draft came from the project advisory committee. They evaluated the materials in terms of technical accuracy, topic relevance, validity and balance of perspective.

The next phase of evaluation involved a test of classroom utility and student reaction. Teachers who participated in developing the curriculum along with 125 educators from Great Lakes states and Canada used the materials in their classrooms for six months. During this time, interested teachers took advantage of a unique opportunity to exchange ideas and provide feedback on the curriculum through the Educational Teleconference Network. This private telephone system enabled them to "gather" monthly to share classroom experiences and suggest curriculum revisions.

Questionnaires were distributed to all people who received a copy of the draft curriculum--teachers, administrators and technical Great Lakes specialists. The curriculum was primarily revised to accommodate practical constraints of the classroom.

Distribution

Our philosophy throughout this project has been to focus on our user group--the classroom teacher. Since teachers can be an effective sales force, we have sought their active involvement in the curriculum's development. With this strategy in mind, our dissemination phase has involved a three-step process:

1. The first year we began to develop a ready-made audience for the materials. Participants from workshops at teacher conferences, respondents to a needs survey, contacts from our project

advisory committee and readers of the Lake Connection newsletter evolved into a network of interested Great Lakes educators;

2. The second year involved working closely with selected teachers throughout the region who were field-testing and evaluating the materials. They shared the curriculum with other teachers and are now helping to organize in-service workshops and teach fellow teachers how to tailor the curriculum to their local needs;

3. Building on this network of educators we are now in the process of identifying educational organizations and agencies to take the lead in distributing materials in their own region.

Results and Summary

A multidisciplinary curriculum that focuses on the Great Lakes has been developed. While materials are targetted for teachers of grades kindergarten through eight, they also appear to be appropriate for non-school educational programs, i.e., 4-H, scouts, environmental centers. Activities are designed for easy integration into existing studies and include everything from basic ecological principles, folklore and music to international trade, using the Great Lakes as a unifying theme.

To accomplish this task, we have drawn on the expertise and practical experience of classroom teachers, curriculum designers and Great Lakes experts. Materials have been field-tested and evaluated by 300 educators from Minnesota, Wisconsin, Illinois, Indiana, Iowa, Ohio, Pennsylvania, New York, and Canada.

In the process of developing the Great Lakes curriculum, we have recruited a network of more than 1,000 educators who have offered reactions and suggestions to our approach and ideas. In our final year, we are enhancing this involvement by linking with educational organizations, public agencies and institutions to distribute the materials and train teachers.

This project has catalyzed a flurry of activity and interest in Great Lakes education. Wisconsin's Department of Public Instruction is in the process of developing new curriculum standards for students and teaching competencies for teachers. For the first time, a requirement of Great Lakes literacy will be included. Teacher demand for access to Great Lakes information is growing as a result of this project. The International Joint Commission has recognized this need and are in the process of developing a computerized data base of Great Lakes resources. An Ontario school district is developing their own Great Lakes curriculum tailored more specifically to Canada. They have credited this project as a model for their own curriculum design.

This project is unique in terms of using the Great Lakes as a tool for developing children's learning skills. In the process, we have established a regionwide network of Great Lakes educators. While the project is in its final stages and a formal evaluation is in the process of being tabulated, the enthusiastic response of teachers anxious to use the materials clearly shows that this project is a success.